

**University of Oslo  
Department of Informatics**

**Developing wireless  
communication  
services**

**The future is in the  
air**

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# Summary

During the last one and a half year I have been working with this thesis, where both empirical and theoretical studies are prominent. Mobile informatics is the subject of my research, and through my studies I have gained more knowledge about this area. By writing this thesis I hope to give a contribution to the mobile aspect of computer science.

The empirical work consists of case studies I have accomplished in two different Norwegian companies. The first is a public transport information provider called Trafikanten. I have studied the services they provide, the service for wireless terminals in particular, and also cooperated with a student group that studied their wireless service. The second company, where I did some research, was a consultancy firm called Ementor. Here I both accomplished an interview and I worked there for nine weeks during the summer of 2000.

The theoretical part is founded in my literature studies. The bibliography reflects what I have read during my work with the thesis. By reading a combination of articles, books and sites on the Internet I have established a foundation upon which I have based my discussions throughout the thesis.

Through my research I wanted to find out if there were any differences between developing traditional systems and wireless services. In short, I found that the situation in which services for fixed plug terminals and wireless terminals are used, differs in such an extent that one have to think different when developing these services. So far the development of systems for wireless terminals is a very immature area and no standard method of how to develop such systems is established. I highlight the fact that context is a critical aspect when it comes to developing new services.

# Preface

This thesis is part of my cand.scient. degree at the Department of Informatics at the University of Oslo. The degree is a combination of attending advanced courses for a total of one half year and writing a thesis based on self conducted research for a total of one year.

## Acknowledgement

I would like to use this opportunity to thank the people who have helped me accomplish this cand. scient. thesis:

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- Trafikanten and Ementor deserves a thanks for letting me carry out my case studies in these companies.
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# Chapter 1

## Introduction

Five years have past since I started to study informatics at the university. During these years there has been a constant development in the field I am studying. There seems to be no end to the evolution of informatics, and it appears that the systems and technologies are getting more and more mobile (Katz 1994). This trend caught my attention when I was trying to decide what to write about in my thesis. Not only because the subject of mobile informatics was beginning to raise popularity, but also because I have an interest for small electronic devices. Now I had the chance to take a closer look at them.

There are an overwhelming amount of issues to discuss about the mobile area of computer science. The issues varies from how people use mobile terminals to how they are physically constructed. In my pursuit of a theme for my thesis I simply had to choose a subject I found interesting and try not to grasp over too much. Among all the possible issues, I decided to focus on the design and development of wireless communication services. What do you have to consider when developing for a mobile context? Is it different from developing for a stationary one and what is the difference?

### 1.1 The focus of the thesis

To communicate is a natural part of our lives. We talk to each other on the phone, at work or at school, we read books and watch television. When and how we communicate is all a matter of how we define communication. I believe the phenomenon is closely related to information. In fact, Merriam-Webster (2000) defines communication as *information communicated* and communicate is defined as *to make known* or *share*. The main difference between information and communication is that the

first is something static. It is located somewhere, like in books or in our heads, but as soon as information is shared or made known it is communication. Communication does not necessarily occur directly between humans. We communicate with a computer when using an application or with the television when watching a program, and a book serves as a medium through which we communicate with the author.

The traditional model for communication, illustrated in figure 1.1, is concerned with the process where a sender conveys a message to one or more receivers (Pettersen 2000). The message is transferred with the help of different media, and together the message and media form a representation. Shannon and Weaver (1975) present a similar model of communication in their book *The mathematical theory of communication*, but adds the aspect of noise to the signal sent from the source to the receiver. A closer review of their book is out of the scope of this thesis.

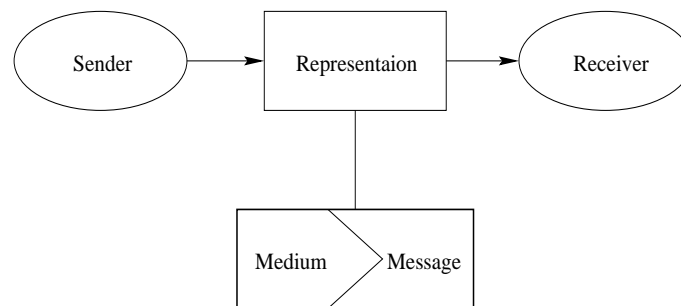


Figure 1.1: Traditional model for communication.

The traditional model represents the sender as the active part and the receiver as the passive part of a communication process, but both the sender and the receiver are actually involved in several activities when a message is communicated. Most often the receiver provides feedback to the sender and the roles are changed. Communicating a message does not just involve sending and receiving, but a combination of several processes, which are performed with the help of tools and influenced by social context. The receiver can actively reach out and grab the representation with its message (Pettersen 2000). This model for active communication is illustrated in figure 1.2

This thesis is concerned with communication and information in a mobile context, whether it is mobility of a person or mobility of the actual information source. The use of mobile phones, PDAs (Personal Digital Assistant) and other wireless terminals is expanding at an explosive rate, and more and more services for such terminals are entering the market.



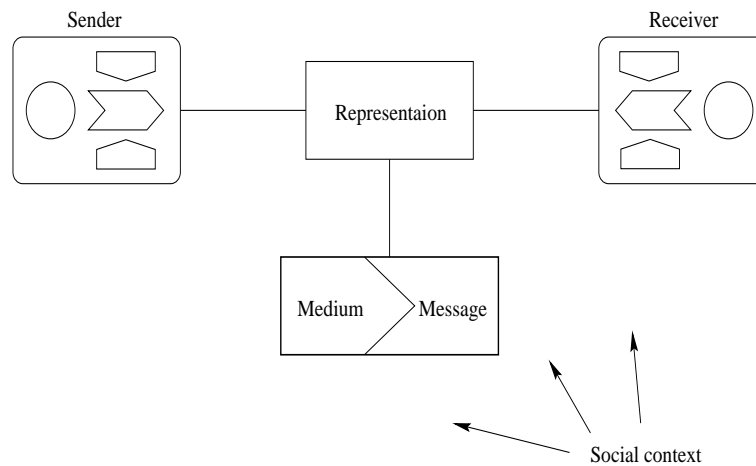


Figure 1.2: Model for active communication. Left circle is the intended message, right circle is the internalized message. Upper pentagons are principles guiding the processes (process arrows) and lower pentagons are tools performing the processes.

One kind of wireless communication service I have studied in particular, is the WAP<sup>1</sup> service provided by Trafikanten. This service is providing online information about buses, trains, subways etc. in Oslo to users with wireless terminals supporting WAP. As soon as someone uses this service it is communication, because the information is shared or made known to the user. It is also an active form of communication, because the user first requests information and the service responds with a search result. During this communication process the user shifts from being the sender to being the receiver.

Since mobility plays a central role in this thesis, I will now explain in short terms what mobility means in the scope of my research. The subject will be outlined in chapter 5. I have decided to concentrate on three partitions of the phenomenon mobility, *personal mobility*, *application mobility* and *terminal mobility* (van Thanh 1997). The first is concerned with the human and its ability to move around and access services from different locations. The second comprises computer programs and services that can be reached independent of net and terminal, like services on the World Wide Web. The last type of mobility covers the devices that can be used independent of a fixed plug, like mobile phones or Personal Digital Assistants (PDAs). As I will explain later, application and terminal mobility makes personal mobility possible. When I throughout the thesis talk about mobile systems I mean services or applications accessed from wireless terminals and when I talk about stationary services I mean ser-

<sup>1</sup>WAP is an abbreviation for Wireless Application Protocol

vices on terminals with a fixed plug. Accordingly I mean terminals with a fixed plug when talking about stationary terminals or devices.

## 1.2 Problem statement

There are a lot of subjects concerning wireless communication. Mobility, design, information, users, stationary versus mobile, technology, just to mention a few, are all interesting subjects to look into. I have chosen three of these subjects to define the problem area of this thesis. The horizontally hatched field in figure 1.3 illustrates what I will consider as the problem area.

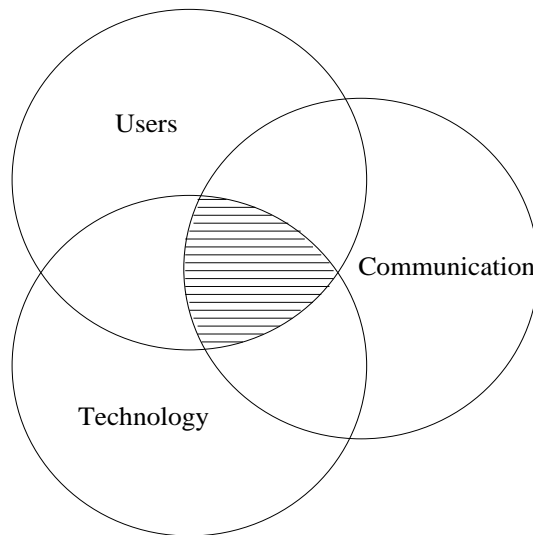


Figure 1.3: An illustration of the problem area. All three fields should be viewed in the light of mobility, since this thesis is concentrating on the mobile area of informatics.

The term *user* is defined as *one that uses* in Merriam-Webster (2000) which is a rather loose definition. There are all kinds of users, such as students, parents, workers, elders, computers, robots and so on. What we mean with a user varies with the context this user is a part of. What the field *Users* in the figure mainly is meant to include in this thesis is the ones using wireless terminals, like mobile phones and PDAs, since mobile informatics is the context of this thesis. I will first of all focus on the human user. I have already discussed the phrase *Communication* above and I will continue to use the definition found in Merriam-Webster (2000) when I talk about communication later in the thesis. The last field in figure 1.3, named *Technology*, embrace the technology that can

be used to offer users the information they need. In this thesis it will be paid attention to wireless technology, like mobile phones and Personal Digital Assistants.

Having defined the problem area it is time to express the problem statement, which the rest of this thesis will try to discuss and answer. The problem statement for this cand.scient. thesis is as follows:

*How does traditional system development differ from developing communication services for wireless terminals?*

The section below gives an overview of the structure of the thesis and what topics I have described and discussed in order to answer the problem statement. The intuitive comprehension of the main difference between traditional systems and wireless services is the situation in which they are used. Sometimes this situation is called the context. This type of situation or context is one of the topics Suchman (1987) talks about in her book *Plans and Situated Action*. She claims that use of artifacts and other human actions always take place in a situation, and that the situation affects our actions. I use the terms situation and context as having the same meaning in this thesis.

There are also a couple of other terms, of which the meaning should be made clear. When I talk about wireless terminals it is mainly terminals like mobile phones and Personal Digital Assistants I mean. There are of course other types of wireless terminals, but it is these I have had experience with during my research. There is also a reason for why I call them wireless and not mobile, something I will get into in chapter 5 about wireless technology.

### 1.3 An overview of the thesis

The discussion of the problem statement and the subject of wireless communication services in general have resulted in a thesis that first presents the theories that much of the discussion is based upon. The first theory is called *borderline issues* and is put forward by Brown and Duguid (1994). The main aspect of this theory is that one can learn a lot about artifacts and how to design them by looking at their central, border and peripheral properties. I have chosen to concentrate on the part of the theory that handles the central and peripheral ones. The second theory is the *design heuristics* presented by Nielsen (1993). He describes ten principles that should be taken into consideration when designing user interfaces. In the presentation of these principles I also discuss in what extent they apply for designing wireless communication services.

Later, in the discussion of the cases, I choose to discuss three of the heuristics, which I believe is of particular interest for mobile informatics. These are *minimize user memory load*, *consistency* and *feedback*.

The next chapter of the thesis describes the methods I have used during my research. Things are first put into perspective by presenting two main scientific views, from which methods for research can be and have been derived from, positivism and phenomenology. Then a short description of the applied methods follow, where literature studies and interviews are the dominating techniques.

Having described both the theories and the methods, the discussion of the problem statement begins with a chapter about traditional system development. What we will see here is that there are several established models for how to do system development for fixed plug terminals. Such systems have been developed for several years and the developers know how to do it. Wireless terminals have recently entered the market, and developing systems for these type of terminals is an immature area of informatics. Much of the focus in this chapter is put on the users' role during a system development process, but it also suggests a placement of where in the software universe (Grudin 1994) the development of wireless services should be placed.

I would like to emphasize the fact that even though WAP services play a central role in my cases, this is only a specific technology I have studied. What I really want to say something about is wireless technology in general.

Before I describe and discuss the cases in detail, where wireless services play a central role, wireless technology in general is presented in chapter 5. The presentation starts with what mobility means in the scope of this thesis and an overview of wireless communication history up until today. Since it is mainly WAP services I have been studying, a description of this protocol follows. The chapter is closed with a few words of what we can expect the future to bring in the area of wireless communication.

In addition to the chapter about traditional system development, the main discussion of the thesis is found in the chapter about the cases. Here is a thorough description of the case I had at Trafikanten, which is a public transport information provider. I describe the different services they provide in short, before I take a closer look at four of them. A part of the case is my cooperation with a student group at the Institute of Informatics. They studied the same WAP service offered by Trafikanten as I did, but did also make a prototype of the same service based on work they did and some of my ideas. There is also a description of a secondary case in chapter 6, which I accomplished at a Norwegian consultancy firm called Ementor ASA. The experience I gained from this case has provided

me with knowledge that I have used throughout my research, but I have not used particular results for analysis and discussion. The last pages of the chapter is a discussion of the Trafikanten case in light of the theories described in chapter 2.

Finally, a chapter with a short summary, a conclusion and a few words about what further work can be done as a continuance of my research closes the thesis.

## Chapter 2

# Theory

In this chapter I build a foundation of what I will base my discussion upon later in this thesis. The first theory I present is that of Brown and Duguid (1994), which deals with what they call *borderline issues*. The second theory is the *design heuristics* announced by Nielsen (1993).

### 2.1 Borderline issues

Brown and Duguid (1994) discuss the concept of borderline issues to highlight the importance of artifacts' resources which often are unnoticed and not appreciated. As figure 2.1 tries to illustrate, artifacts have both central and more peripheral properties. The central properties are those closely associated with the artifact, while the peripheral ones are the more context bound properties. By examining the peripheral properties when designing systems, we also take the context into consideration. This is exactly what Brown and Duguid want us to do.

Between the center and the periphery lies what is defined as the border. Although hard to separate from the center and periphery, the border is a distinct, dividing line. These three concepts are not clear, limited and theoretically well-defined, but rather constantly changing. Hence the irregular lines in figure 2.1. The border comprises those aspects of an artifact and its periphery that are available to each person involved in a particular interaction with that artifact (Brown and Duguid 1994). What are considered to be central or peripheral properties vary from person to person and from group to group.

The resources found at the border, which are shared and form a social meaning for a particular group of people, are what Brown and Duguid call borderline issues. These resources evolve over time as the groups of people or communities of practice make use of the artifact and be-

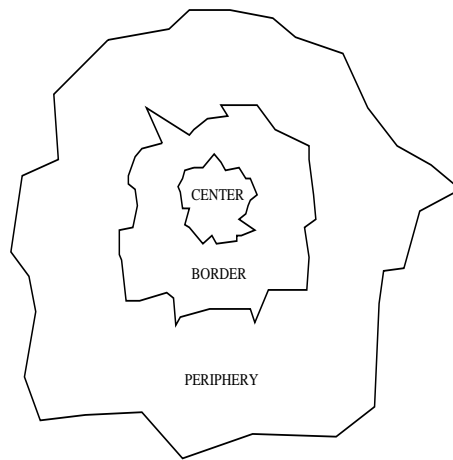


Figure 2.1: An artifact has properties "located" in the center, the border and the periphery.

cause of material continuity. In order to recognize the properties of an artifact there has to be material continuity and the community of common practice is necessary for people in the group to share, realize and reformulate conventions.

Sandahl (1999) uses the terms from Brown and Duguid's (1994) article to explain what happens when paper documents are replaced by digital documents. Based on a case at a Norwegian news agency, she uses the ideas of central, peripheral and border resources to describe a situation where properties of the paper system need to be taken care of when the system is replaced by a digital system. Figure 2.2 illustrates an example of a central, a peripheral and a border property that paper documents can have. These properties were identified in Sandahl's (1999) case study at the news agency, and she emphasizes the importance of preserving such properties in a transition to digital systems.

By taking an artifact's peripheral properties into consideration, we can see what significance they have in work practices and be aware that these properties need to be taken into account when the artifact is to be replaced, removed or changed. This can often be seen in the development of new systems, where designers remove border resources because they are "located" outside what is considered as part of the artifact.

But how does the border work? How can we make it impact the way people think about an artifact? Brown and Duguid try to explain this under four different headings which they have called *engaging interpretation*, *maintaining indexicality*, *Transmitting authority* and *sustaining interpretation*. Below I summarize what they say.

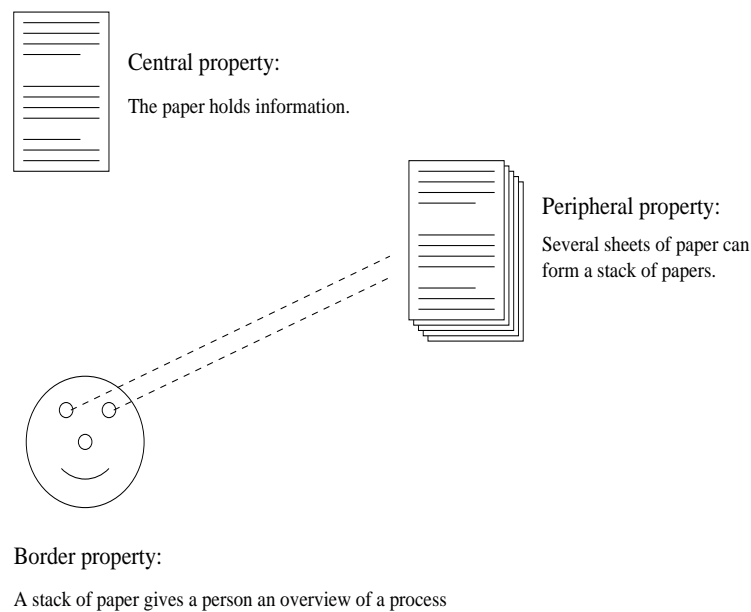


Figure 2.2: An example of central, peripheral and border properties of paper documents.

### Engaging interpretation

The border should guide the way an artifact is supposed to be interpreted. This can be done by using certain clues that are recognized and have the same meaning to several people. Such clues are distinct from personal clues which only have a meaning for one or a few people. By giving the artifact common clues it has a portable context which can be publicly recognized.

An example is how we interpret a book. We can often tell by its cover and layout if it is an academic book or a novel. We do not have to read the book to figure that out. That is because the author and publisher have worked on the border and placed common clues to make the readers interpret the book the right way.

### Maintaining indexicality

Designers of different artifacts are aiming toward certain market segments and away from others. The border can help identify the addresser ("I") and the addressee ("you"), and make the designers hit the right market.



*When moving into new niches, designers have to redirect the implicit "you" - usually by working on the border.*

— Brown and Duguid (1994)

Using indexical terms like *I, you, now, here, there, next, last, tomorrow* and *below* you can index or point to the context of communication or more precisely the socially accessible periphery of communication. Indexicals are therefore related to the periphery properties of an artifact.

The problems arise when communication occur over time and space, and the involved participants do not have a shared periphery. What do the indexicals mean in such situations? You need to know or be part of the context to understand what words like *here, there* and *now* means. A message on an answering-machine can serve as an example. If you receive a message which says "I will meet you tomorrow", you need to know who left the message and when the call was made to understand what "I" and "tomorrow" mean. One way to solve this problem is to provide a portable context or a border that explains the indexicals' meaning, so the words can remain robust over time and space. The header of an e-mail message provides such a context. If the message says "I will meet you tomorrow", you can interpret the message by looking at the header which tells you who the message was from and when it was sent.

### **Transmitting authority**

The third way one can work at the border is to use it for transmitting authority. To understand communication it is often not enough to know who said what to whom, but you also need to know with what authority and under what conditions the communication was carried out. Taking advantage of the border, especially the physical form of a communication and its different structures, can help embody, maintain and represent authority. People often demand important and valuable artifacts to have watermarks, letterheads, specific types of ink etc.

One aspect that gives an artifact authority is its *social inertia*, a phenomenon Brown and Duguid define as "the extent to which objects can demand significant resources to get into circulation and resist changes once there." An example are hefty books which need a great amount of resources to get into circulation, and the publishers will avoid to take them back to correct errors. Their heft provide the books with more authority than the word *authoritative* on the cover would have.

The trend nowadays is that many artifacts are digitalized, like an dictionary published on the World Wide Web instead of as a physical book.

This is an example of how materials' forms change, and when they do, designers and users must find new ways to establish authority.

### **Sustaining interpretation**

One thing is to use the border to help interpretation to get under way, but it can also help to sustain it.

If you work on a computer (in this case a rather old one) and you simultaneously print a document, the task you are working on will slow down because of the printing. This indicates how long it takes to print the document and when it is done. It does not interrupt with your main actions, but only slows them down. Explicit signals can, on the other hand, interrupt in a way that requires that the user understands and interprets the signal.

#### **2.1.1 Applied theory**

The principles of Brown and Duguid's (1994) theory are presented above and I will now argue for what parts of this theory I have applied in my research. Using a theory can be compared with using a computer program, like a word processor. Think for example of all the functions Word for Windows has. But even though all these functions are available it does not mean you have to use all of them every time you write a document in Word. What functions you use depend on what you would like to do. The same principal apply for using theories. Instead of using all the aspects of a theory, you can use the parts suitable for your needs.

The ground rule, though, is to be true to the fundamental principals of a theory. I believe the foundation of the theory about borderline issues is the different properties of an artifact. To be true to this foundation, I have chosen to concentrate on the parts of Brown and Duguid's theory which handle the central and peripheral properties of artifacts. The reason for this is that I have not done comprehensive user surveys for the wireless services I have been looking at, and I believe that is required to identify border properties and resources for these services. I have therefore chosen to use the theory in a way where I look at each side of an artifact's borderline: at the central and the peripheral properties. This way I still mention the border, but it is not the most important aspect in the way I use the theory. I consider the context of an artifact as very important, and this can be studied by looking over the border from the central to the peripheral properties. By identifying the peripheral properties I can find out whether the context of an artifact plays an important role or not.

## 2.2 Heuristics for user interface design

When designing user interfaces there are certain rules you should follow (Nielsen 1993). These rules are what Nielsen calls heuristics, but he also uses the words principles and guidelines for the same purpose. The word heuristic, in this context a noun, is a specific rule-of-thumb or an argument derived from experience. Nielsen lists ten heuristics for how to design good user interfaces. These are:

1. Simple and natural dialogue.
2. Speak the users' language.
3. Minimize user memory load.
4. Consistency.
5. Feedback.
6. Clearly marked exits.
7. Shortcuts.
8. Good error messages.
9. Prevent errors.
10. Help and documentation.

Nielsen claims that these principles apply for designing almost all user interfaces. If this is true, it means that they also apply for user interfaces on wireless terminals. Since Nielsen wrote his book in 1993, when mobile informatics was not such a hot subject as it is now, it is just an assumption that his heuristics apply for interfaces on mobile devices too. In the following I will describe and discuss the ten heuristics and try to evaluate their tenability in the context of services on wireless terminals. When appropriate I also refer to other articles and books that discuss the same topics as Nielsen does. I will especially refer to a report called *User interface guidelines for WAP applications* written by three employees at Telenor Mobil (Grimstad, Stegavik and Saastad 2000). They discuss many of the same design principles as Nielsen does, but applied for designing interfaces on WAP enabled terminals. Even though much of the report is aimed at WAP enabled devices, they have tried to make the guidelines for design as general as possible, and should be applicable to most wireless communication devices.

### Simple and natural dialogue

You always have to have in mind who the interface is designed for. The interface will be of no use if the user himself does not know how to interact with it. In an ideal world only the information the user needs should be presented to him at exactly the place and time it is needed. Since we are not living in an ideal world, we have to be aware that all units of information compete about the user's attention. It is therefore important not to present irrelevant or rarely needed information and to adjust the interface to the user's tasks in a natural and logical order.

Information overload is a typical example of bad design. When the user is faced with too many choices and possibilities he can easily get distracted. This also applies to the use of colours. Never exaggerate and make sure that the interface can be used without colours, as someone actually still has black and white screens. Colours should be used to categorize and emphasize, not to give information.

This heuristic also applies for interfaces on wireless terminals. There should be no difference in the use of simple and natural dialog between services on such terminals and fixed plug terminals. The heuristic is actually very important to follow when designing an interface on a mobile device. This is mainly because of the situation the user of such a device is in, where he often needs to quickly understand what information is presented in the interface.

### Speak the users' language

This principle is related to the previous principle about a natural dialog. The words, phrases and concepts should be clearly expressed in a language familiar to the user, and not in system-oriented terms. All interaction should be based on the users' view. But since users are different, the system should accept synonymous words and phrases. One aspect that can make a dialog good, is that there is a good relation between how information is presented and the users' conceptual model and understanding of the problem domain.

Norman (1990) is another author that emphasize the importance of a correspondence between the users' and the designer's conceptual model. He does not talk about user interfaces in particular in his book *The Design of Everyday Things*, but the concepts he talks about can be transferred without much effort. Norman describes *the conceptual model* as part of our mental model. It says something about how you interpret different artifacts. The designer of an artifact has one model, but the user has another one. These models need to correspond as much as possible.

Another way of describing the user's conceptual model is what the user is likely to think and how the user is likely to respond (Liddle 1996).

According to the principle of the conceptual model, a designer's success depends on his understanding of how a user is likely to think and respond. This requires that the user takes part in the design process. In the discipline of design you stand with one foot in two worlds (Liddle 1996); a world of technology and a world of humans and human purposes. To succeed you need to combine these two worlds, and that is not possible without cooperation between people.

The same arguments apply for this heuristic as for the previous one, when it comes to designing interfaces on wireless terminals. When being in a mobile situation the user might not be able to concentrate and hold his attention on the device. It is therefore important that the user understands the events and information presented in the interface fast and easy. This can be done by paying extra attention to the fact that the interface is adjusted to the user's task and to make sure the limited resources are used as effectively as possible.

Grimstad et al. (2000) have made up a list of how they believe the language, types and fonts should be in services for wireless terminals. I present the list below and do not describe it in more detail because it is rather self explanatory.

- Use the users' native language.
- Use capital letters only where they belong.
- Keep it short.
- 7 characters in menu items.
- Information in normal fonts.
- Bold is for important information.
- Big types are for status messages.
- Small types are for explanatory purposes.
- The fonts must be easy to read.
- Minimize the number of sizes and fonts within a page to support readability.
- Headlines are for navigation.

### Minimize user memory load

People are much better at recognizing than remembering. Users should therefore not have to remember information from one part of a dialogue to another, or to use certain commands to perform a task. It is the computers that should be the ones who remember. It should also be easy to retrieve instructions for use whenever appropriate. The entire system should be based on consistent rules, so the user does not have to do the same instructions in different ways throughout the system. One such example is the cut-and-paste function, which is done in the same manner on almost all systems.

When you sit in your office using some kind of computer service, you do not always have to overcome limitations like short-term memory and attention span. You can for example make notes on a sheet of paper or use more time to accomplish a task. In a mobile situation things are a bit more complicated, as we can understand from the list below (Grimstad et al. 2000):

- *Complex environment.* The user may be outside and perhaps on the move. This situation differs significantly from sitting by a desk at the office. Unexpected interference makes less attention available for the wireless service.
- *Perceived pressure.* The user might feel he is under pressure and therefore be stressed and loose attention.
- *Less support.* It is not likely that the user will be able to make notes in a mobile situation, like he would if he was sitting by a desk in his office.

The above list serves as arguments for designing interfaces on wireless terminals that minimizes the users' memory load. The user should not have to remember codes, numbers or other information from one part of an application to another. When the user is faced with choices, they should be presented to him so he does not have to remember them. The user should not have to make complex decisions. One way of doing this is to divide the problem if possible.

### Consistency

One of the most established rules for designing a good interface is to provide for consistency. This does not only mean making the design consistent, by presenting the information in the same manner and at

the same place everywhere in a program, but also to ensure for consistency in functionality and structuration of tasks. While this is a job for the designer, agreed-upon standards for the interface can help decide the consistency of the dialogue. Different words, actions and situations should never mean the same, and there should not be any reason for users to believe so either.

Jonathan Grudin (1989) is another researcher talking about user interface consistency in his article *The case against user interface consistency*. He argues that one should not always strive for consistency. There are three different types of consistency according to Grudin. The first is internal consistency of an interface design, where consistency might be sought in physical and graphical layout, command naming and use, selection techniques, dialogue forms, etc. The second is external consistency of interface features with features of other interfaces familiar to the users. Even though an interface is internally consistent, it can conflict with other interfaces. It is often hard to achieve both internal and external consistency, because the designer does not always know what other applications the user is familiar with. The third type of consistency is correspondence of interface features to familiar features of the world beyond computing. One example of such a consistency is the trash can used both in the real world and as an icon on many desktops.

Grudin gives several examples of designs where consistency would not give the best solution. One such example is the typewriter keyboard. The first keyboards were alphabetic and in that sense consistent with the fact that we are familiar with the alphabet. But research has shown that other solutions might be better because keyboard design has to take into consideration, among other factors, human physiology, motor control and the properties of the language to be typed.

Even though Grudin argues that consistency is not always appropriate, I believe that services for wireless terminals at least should have internal consistency. Since such services most often are presented on small screens, all the information might not be presented in a single page. Information should be presented in the same manner throughout all the required pages. Another feature that should be consistent on wireless devices is the way the user gives input to a service. Grimstad et al. (2000) claim that selecting is better and faster than writing. The input capabilities are limited and to select something from a list or menu is simpler than entering text manually.

## Feedback

The worst situation when a system error has occurred, is not to get any feedback from the system. Based on their input, users should be kept informed within appropriate time, both through positive feedback and messages of error. There should also be some kind of partly feedback during the progress of information. Feedback is also a term Norman (1990) mentions. He says that by the help of sounds, lights, displays etc. the user should get immediate and obvious effect of the action he just performed.

Nielsen mentions three different types of feedback that require different attention:

1. The feedback is interesting in a certain period, and then disappears.
2. The user must inform that the message is perceived.
3. The feedback is a permanent part of the interface.

This heuristic is perhaps the most important one when it comes to designing interfaces on wireless terminals. Being on the move you can not always concentrate your attention on the device, and in such situations the feedback should be a sound or light signal. Feedback should both give indication on whether the input had a valid format and the result of the operation (Grimstad et al. 2000).

## Clearly marked exits

Most users are humans and humans make mistakes. This apply no matter how good the interface is. The users should always be able to easily exit an unwanted state of a program.

The report written by Grimstad et al. states that wireless services at least should have a function for going back one step in an application, like a "back" button, and a function for bringing the user back to a certain start page, like a "home" button.

## Shortcuts

Some users have more experience than others. An interface should therefore provide expert users with the opportunity to use shortcuts or accelerators to perform certain tasks. These shortcuts will be unseen by the novice user. In this way the system is adjusted to both experienced



and inexperienced users. Shortcuts can be presented in several different manners, like an abbreviation, a function key or function buttons visible in a dialogue. There should be no reason why this heuristic should not apply for designing mobile services too. There will always be people with different experience using wireless terminals.

### **Good error messages**

Providing good error messages is related to the feedback heuristic. The messages should be stated in a simple and clear language and not use cryptic words or codes. They should be precise instead of general and vague, and presented in a politely manner. Do not offend the user by blaming him. Instead give constructive help to the problem.

Just as important as the good error messages is an easy way out of the problem or situation. If the user would like more information about the error, it should be possible for him to retrieve it.

The Telenor report by Grimstad et al. states much of the same as Nielsen does about error messages. This should mean that the heuristic should be followed also when designing interfaces on wireless terminals.

### **Prevent errors**

Even better than providing messages when an error occurs, is to avoid the error in the first place. This is partly done by thinking before designing. One way is to do user testing where the user errors are logged to detect system errors. This is obviously a general heuristic concerning services on both fixed plug and wireless terminals.

### **Help and documentation**

Users often do not read any documentation before they are in a particular situation where they need help. Because of this, any documentation should be task oriented, not too large, easy to search and list concrete steps to be carried out by the user. Online help is sometimes appropriate, but it is required that it is easy to manage and context sensitive. Providing updated help holds for both printed documentation and online help.

In a situation where the user is mobile he might not be able to use much time on using help functions or reading documentation. One should therefore put extra effort in providing help and documentation that is easy and fast to use.

## Chapter 3

# Method

I start this chapter by describing two fundamental philosophical views, from which one can derive methods for research. This is to put things a little into perspective before I continue with a description of the different methods or techniques I have used to gather information for my study.

### 3.1 Two main scientific views

For several centuries there has been a debate of what philosophical position methods should be derived from. Positivism and phenomenology are two opposites in this debate, and many methods are derived from one or a combination of these views. Even though there are or have been people speaking the case of one or the other, no one is either positivist or phenomenologist (Easterby-Smith, Thorpe and Lowe 1991).

#### Positivism

The basic view of positivism is that the social world exists externally (Easterby-Smith et al. 1991). This imply that its properties can be measured through objective methods. Auguste Comte was one of the main advocates for the positivistic ideas in the mid 1800. One of his statements was:

*All good intellects have repeated, since Bacon's time, that there can be no real knowledge but that which is based on observed facts.*

*- Auguste Comte*

This statement has two assumptions in it. One, there is an external and objective reality. Two, knowledge is only of significance if it is based on observations of this external reality.

Positivism has its roots in the tradition of empirical, natural science, where reductionism is one of the principles (Patel and Davidson 1995). Reductionism means reducing a problem into elements and study each element separately. The researcher is external and objective and the goal is to gain useful, improving, reliable, exact and organized knowledge (ibid.).

### **Phenomenology**

Phenomenology, on the other side, is based on the belief that reality is socially constructed and not objectively determined (Easterby-Smith et al. 1991). This view or paradigm (Kuhn 1996) arose during the last half century as a response to the positivistic ideas, and it stands for the opposite of what positivism does. For a phenomenologist it is important to understand and explain, and not to do research by measuring different properties.

Hermeneutic is a term that means to interpret or expound (Lübcke 1983). This notion has gained special interest in the area of phenomenology and can now be seen as a major part of this philosophical view. Philosophers of the phenomenologic paradigm have used the term to explain how to interpret, understand new things and what the truth is. Hermeneutic was first, in the 1600-1700, a method for interpreting sacred texts, but later became a method for interpreting all texts. More modern hermeneutics also interpret human action and manifestations of life. The role of the researcher is subjective, open and committed, and in contrast to positivism it is the totality that is interesting.

## **3.2 Applied methods**

When you shall accomplish a research of some kind you always start with a problem (Patel and Davidson 1995). A problem in this sense is simply something you are interested in gaining new and more knowledge about.

There are however several different ways to gain information about a subject. Patel and Davidson (1995) list three ways of doing scientific research:

1. *Explorative*. This comprise the investigating methods. There are gaps in our knowledge, that we would like to fill. We obtain information about a certain problem area, often by using several different techniques.
2. *Descriptive*. We already have a certain amount of knowledge. These methods are characterized by the detailed and thorough examination of a few aspects of a phenomenon. Usually one technique is used for obtaining information.
3. *Testing of hypothesis*. When using methods including testing of hypothesis it is required that you have comprehensive knowledge in the area of concern. You deduce and test assumptions or hypothesis out of theory.

In my research I have made use of several techniques to obtain information. I have used this information to fill the gaps in my knowledge of the area of concern. Based on this I believe my research can be categorized as explorative. The different techniques or methods I have used are described below.

## Interview

Most of the information I have gathered in my case studies is based on interviews or conversations with the participants. The interviews were not strictly structured, of the kind where the interviewer ask all the questions and the respondent answers the questions. They were more like conversations where all the participants talked and discussed several topics. According to Patel and Davidson (1995) interviews have a certain degree of *standardization* and *structuration*<sup>1</sup>.

The degree of standardization is to what extent the questions asked at the interview are formulated before the interview. At fully standardized interviews the same questions are asked in the same order to every respondent. At interviews with no degree of standardization the questions are formulated at the time of the interview and asked in an order suited for a certain respondent. I would characterize the interviews I have accomplished as medium standardized. By that I mean that the questions were partly formulated before the interviews, but they were open for adjustments during the interviews.

The degree of structuration is to what extent the respondent can vary his answers. A fully structured interview gives the respondent little possibility to vary the answers. Most often the answers are given as alternatives,

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<sup>1</sup>These terms are translated from Norwegian.

and the respondent must mark one or more of the alternatives. At interviews with a low degree of structuration the respondent can talk freely and is not committed to certain answer alternatives.

I have spoken with several persons at Trafikanten, in what I will call group conversations. At one such conversation we were eight people participating. The group conversations were structured in a manner where I and my internal advisor discussed what we would like to know about Trafikanten before we attended the conversations.

I also had an interview with a Telenor employee together with my internal advisor and one with an Ementor employee. These interviews were structured in the same manner as the group conversations.

In addition to the interviews and conversations, I have exchanged several e-mails with people at Trafikanten. I have gained much knowledge through these e-mails and consider them as written interviews. I often sent an e-mail instead of organizing a meeting, when I just had one or two questions to ask.

### **Literature studies**

Together with conversations, literature studies are the main method used in my cand.scient. study. As one can see by the bibliography at the end of this thesis I have referred to articles and books, which serve as a foundation for my discussions in the thesis. I have used the literature to gain knowledge in areas I previously did not have much knowledge about.

### **Prototyping**

Through my cooperation with a group of students attending a course called *Development of interactive web-services* (IN-DIW 2000), I indirectly made use of the prototyping method. The group developed a prototype for Trafikanten based on their and my ideas, and I have used the result in this thesis. In section 4.2.2 on page 31 in the chapter about traditional system development models you can read more about prototypes.

### **Technology studies**

Technology studies is a technique I have used more or less unconsciously. Since I have an interest for small electronic devices I have both a mobile phone and a Personal Digital Assistant (PDA). I use these frequently and have gained experience with both. Even though my daily use of such

devices is not directly connected with my research, I believe I can take advantage of this experience when discussing the use of wireless terminals.

The way I used technology during my work period at Ementor was more consciously directed to the area I am studying. I spent a great deal of time testing out a WAP emulator. I also gained experience in developing programs for the WAP technology.

### **Participating studies**

During the summer 2000 I worked as a consultant at Ementor, developing an intranet service for WAP enabled terminals. During these two months I gained knowledge that only can be gained through personal attendance, by doing things yourself. Even though I did not always try to correlate all I did with what I am studying in this thesis, the total experience of being part of such a development process has given me an understanding which has been useful during my research.

### **User survey**

One of the first things I did in my study was to accomplish a small user survey about the WWW service provided by Trafikanten. This was conducted to get a feeling of what people thought of their service and to get started with my research. The survey and its results can be found in appendix A on page 83.

The IN-DIW student group also accomplished a couple of user surveys in their project. The first was a survey of the WAP service provided by Trafikanten, where the respondents were to try out the service and say a few words about what they thought of it. The second survey focused on the prototype the student group had developed. This survey was much like the first one, even though the results were a bit different. In both surveys there were four test persons or respondents. According to Nielsen (1993) studies of user interfaces have shown that four to five respondents can find between 75% and 80% of all the errors in an interface being tested. The IN-DIW surveys can be found in appendix C on page 90.

### **Scenarios**

Scenario is a technique I have used to identify different properties in the services provided by Trafikanten. The properties I have identified are

of the types discussed in Brown and Duguid's (1994) article *Borderline issues: social and material aspects of design*, which I presented in the previous chapter about theory. The scenarios are presented in appendix B on page 87.

There are several definitions of what a scenario is. In the context of systems development and user interaction Carroll (1995) describes it as

*... a narrative description of what people do and experience as they try to make use of computer systems and applications.*

Scenarios can be used for representing, analyzing and planning how users' activities and experiences should be affected by a computer system.

Others have also described what a scenario is:

*A scenario is a description of an activity, in narrative form* (Nardi 1992).

*At the most general level, scenario refers to a situation or more precisely (since it has a temporal component), an episode* (Wright 1992).

*A scenario is a sequence of actions showing how a transition from one state to another might occur* (Anderson and Durney 1992).

Even though not all services offered by Trafikanten are computer systems or applications (e.g. the paper based timetable), I believe all definitions suit the way I have used scenarios in this thesis. Of the four definitions or descriptions above it is just Carroll's definition that focuses on the use of computers. I believe one can extend his definition to also include non computer based systems, like a booklet of timetables.

The main advantage of scenarios is that the focus is on the user. What is the user doing, what does he perceive and what does it all mean to him when faced with a system or application of some kind (Carroll 1995). Scenarios are a way to support the system development lifecycle and this linkage between designers and users can help increase the efficiency of communication. By making use concrete and providing an informal and conversational style, scenarios make it easier to discuss and design use.

There are other ways to represent a scenario than in writing. You can make use of techniques like storyboards, video mockups, scripted prototypes and physical situations. It all depends on the context in which you are working. Sometimes one technique is superior to another, other times it is exactly the opposite. With all these methods you can vary the level of description and detail.

Scenarios are not a very useful technique if they do not take the right user into consideration. It is therefore critical that some analysis is made, as to what user groups are relevant and not. Using scenarios is not always an appropriate approach. They can not substitute full analysis, a list of user requirements or an exhaustive set of specifications in all situations (Carroll 1995). You have to carefully consider if they will be a help for you or just extra work with no profit.



## Chapter 4

# Traditional system development models

When studying new and modern technology, communication services and trends of today's society, I believe it is important to do that based on how things traditionally are done. Not to say that we should not think in new ways, but maybe it can help us see what are to be changed and not. The purpose of this chapter is to look at how system development traditionally have been done up until today. This can form a basis for a discussion about how services for wireless terminals should be developed. Should we do it the same way as we have done with stationary services, or do we need to think in a completely different way? Or is it perhaps a golden mean to follow, with a combination of old and new thinking?

An important issue in system development today is the role of the user. For that reason the topic will also play a major role in this chapter. User participation has been a subject in system development for several decades and the question has been, and still is, to what extent the users should take part in the system development process. The different development models handle this question in various ways. One of the main issues in this chapter is how the waterfall model, prototyping and the spiral model handles challenges and problems arising when users of a future system are included in the development process.

Floyd, Reisin and Schmidt (1989) talk about user participation in their article *STEPS to software development with users* and mention that there are both use perspectives and development perspectives on a system. The competence needed for developing a software system is located both with the users and the developers, and the challenge is to combine the competence so the users get the systems they need. The extent in which the waterfall model, prototyping and the spiral model manage

to combine the competence of users and developers and their different perspectives is also an issue in this chapter.

I start by building a foundation to base the rest of the chapter upon. This foundation will be composed of a classification of software development, a description of the three models of interest and an evaluation of the basis in which the three models have been developed upon. The chapter continues with a discussion of some challenges and problems that may arise when users are taking part in a development process and how the three models handle this. At the end I summarize the chapter and draw some conclusions from the discussion.

## 4.1 A classification of software development

Before I start discussing the three models of system development I believe it is appropriate to place the subject of this chapter into a framework. This is just to put things into perspective before we look into the details of each development model. At the end of the chapter I will use the framework to classify another type of system development than the traditional ones, that is the development of services for wireless terminals. The framework is based on an article called *Groupware and social dynamics: eight challenges for developers* (Grudin 1994). Figure 4.1 illustrates the framework which classifies different types of software systems in the software universe.

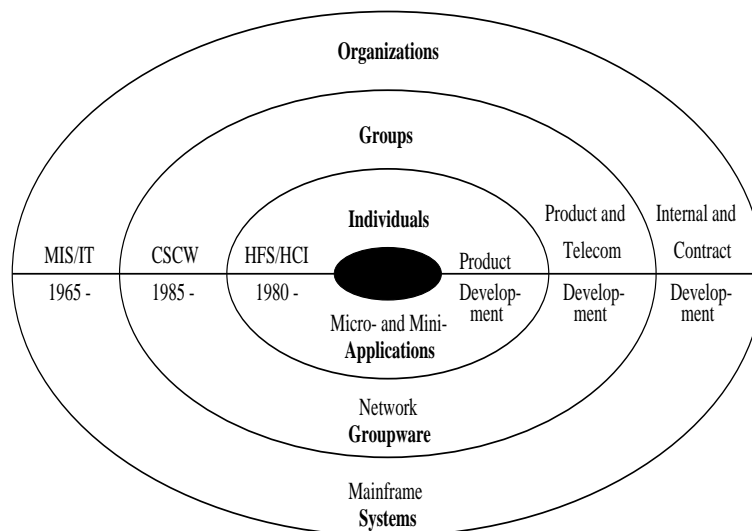


Figure 4.1: A classification of software systems in the software universe.

Groupware is the focus of Grudin's (1994) article, but here we will look at the figure and its classification separately from the rest of the article. The structure of the figure is as follows: on top are the users of different software systems, to the right are the principal software development contexts, on the bottom are the different types of systems developed during the last 30 to 40 years and to the left is research development literature produced as a result of the emergence of new software development areas.

As we can see, the first systems developed (in the 1960s) were supporting large organizations. These systems were a result of either internal or contract development and produced literature about Management Information Systems (MIS) and Information Technology (IT). The reason for developing such large systems was that the expense of early computers required that they addressed major organizational goals (*ibid.*).

In the 1980s the spread of personal and interactive computers started, and markets for systems for individual users were created. This resulted in an interest for and literature about Human Computer Interaction (HCI) and basing systems on Human Factors (HF). Most of these micro and mini applications are developed in the context of product development. Examples of such applications are spreadsheets and word processors.

The last type of systems developed are the groupware systems, which most often are results of product or telecom development. This expression emerged in the mid-1980s, together with the term Computer Supported Cooperative Work (CSCW), and a huge amount of literature has been written about these types of systems too.

## 4.2 Three models for system development

People have developed software systems for decades, and in the development process there have been used several different models for system development. These models provide guidance on the order in which a project should carry out its major tasks (Boehm 1988). This section discusses three such models, the waterfall model, prototyping, and the spiral model. Before I go into the details of user participation support in these models, I will give a description of their main features.

### 4.2.1 The waterfall model

The waterfall model was developed in the 1950s and 1960s, and has been widely used since then. In fact, this model has become the basis for

most software acquisition standards in government and industry (Boehm 1988).

It has received its name from the way the stages in the development model fall from one phase to the next. Figure 4.2 illustrates a typical waterfall model with five phases. The phases reflect the main tasks of a

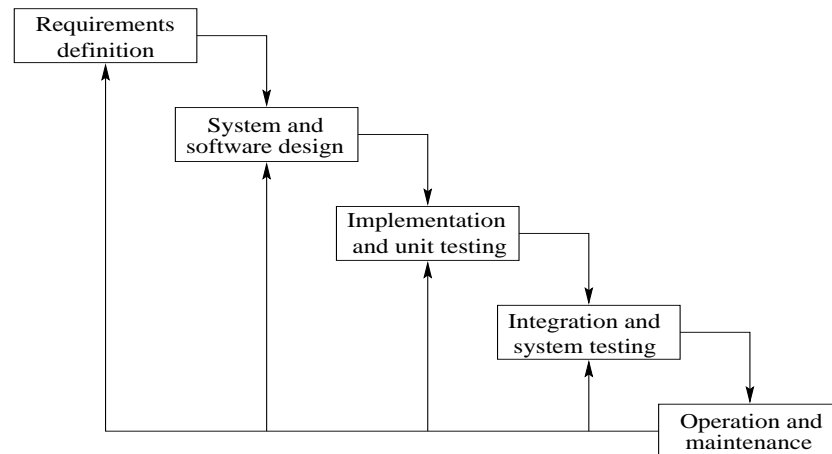


Figure 4.2: The waterfall model cascades from one phase to another (Sommerville 1995).

system development process or put another way, the software lifecycle, which is described in the list below (Sommerville 1995):

1. *Requirements definition.* In this phase the goals and constraints of the system are established. This information is usually collected in cooperation with the users.
2. *System and software design.* The requirements from the previous phase are divided into either software or hardware systems, and a full system architecture is established. The functions should be represented in such a way that they can be transformed into one or more executable programs.
3. *Implementation and unit testing.* This phase realizes the design as one or more programs. The testing involves making sure that each unit satisfies its specification.
4. *Integration and system testing.* Every unit is integrated and tested in this phase. The system as a whole must satisfy the specification and then the system is delivered to the customer.
5. *Operation and maintenance.* This is the phase where the system is installed and put into use. Usually there has to be done some

error handling. This is normally the longest phase. Maintenance and enhancement of the system are part of this phase.

In contrast to the earliest stagewise models, the waterfall model provides feedback loops between the different stages. This possibility to go back to previous stages and correct errors or make specifications, makes the model an iterative one. Because of this feature it has become usual to freeze the specification at a certain point in the process (Sommerville 1995). Any problems caused by this freezing have to be solved in later stages, which gets more expensive as longer you are in the process. Too early freezing of the specification might result in another system than the one the users want.

One advantage of the waterfall model is its clear defined milestones. It also delivers structured documents at each defined milestone, which makes the process visible. But the model also has its disadvantages. It is hard to change the goals during the process. This is partly due to the focus on early requirements specification. Many would also say that it is a document driven approach and that the papers are produced for the sake of the papers.

#### 4.2.2 Prototyping

The second model discussed is prototyping. Prototyping does not need to be a model of its own, but can be part of other models as we shall see later in the description of the spiral model.

Prototyping as an approach to system development came under discussion in the late 1970s (Budde, Kautz, Kuhlenkamp and Zullighoven 1991), as a way to make use of experimental methods. The basic concept about prototyping is that it involves producing early working versions of a future system and experimenting with these versions. Through this experimentation problems are clarified and the developers are gaining experience. This way of doing system development provides a communication basis for discussion, especially between users and developers. Figure 4.3 shows a typical process model for prototyping. The boxes with the rounded corners represent the stages in the process and the rectangular boxes represent the results of the stages.

In Budde et al. (1991) three different prototypes are mentioned. The first is *prototype proper*, which is a preliminary working system that is developed in parallel to the information system model. It is designed to demonstrate certain aspects of the user interface or part of the functionality.

The second type mentioned is *breadboard*. This is a prototype that helps

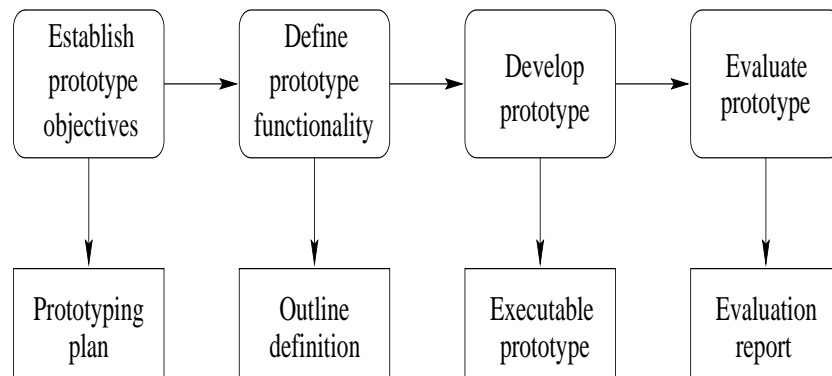


Figure 4.3: The process of prototype development (Sommerville 1995).

clarify construction-related questions facing the developer team. This kind of prototype does not involve any users and is therefore a restricted form of prototyping.

A *pilot system* is the third kind of prototype Budde et al. (1991) talk about. Pilot systems are employed in the application area as the core of the future system, and their increments should be geared only to user priorities.

Budde et al. (1991) do not only distinguish between three kinds of prototypes. They also describe three kinds of prototyping:

1. *Exploratory prototyping* is an often used approach when the problem in hand is unclear. Different prototypes proper are frequently subjects for discussion.
2. *Experimental prototyping* has a focus on the technical implementation of a development goal. It is important that the technical problems that may arise are discussed with the users.
3. *Evolutionary prototyping* has a focus where prototyping no longer is just a tool, but is seen as a continuous process for adapting a system to rapidly changing organizational constraints.

Prototyping is an useful approach for developing small to medium sized systems, for parts of larger systems or for systems with a short lifetime. It gives the users an early feeling about the future system, and misunderstandings can be solved at an early point in the process.

### 4.2.3 The spiral model

The last system development model to be discussed in this chapter is the spiral model. This model is an attempt to combine specialized approaches during a development effort (Mathiassen, Seewaldt and Stage 1995), approaches like the waterfall model and prototyping. Boehm (1988), who is the father of the spiral model, claims that it can accommodate most previous developed models as special cases. The main feature of this model is its focus on minimizing risks in the development process.

An illustration of the cycles in the model is given in figure 4.4. The radial dimension in the figure represents the cumulative cost incurred in performing the steps to date, and the angular dimension represents the progress made in completing each cycle of the spiral.

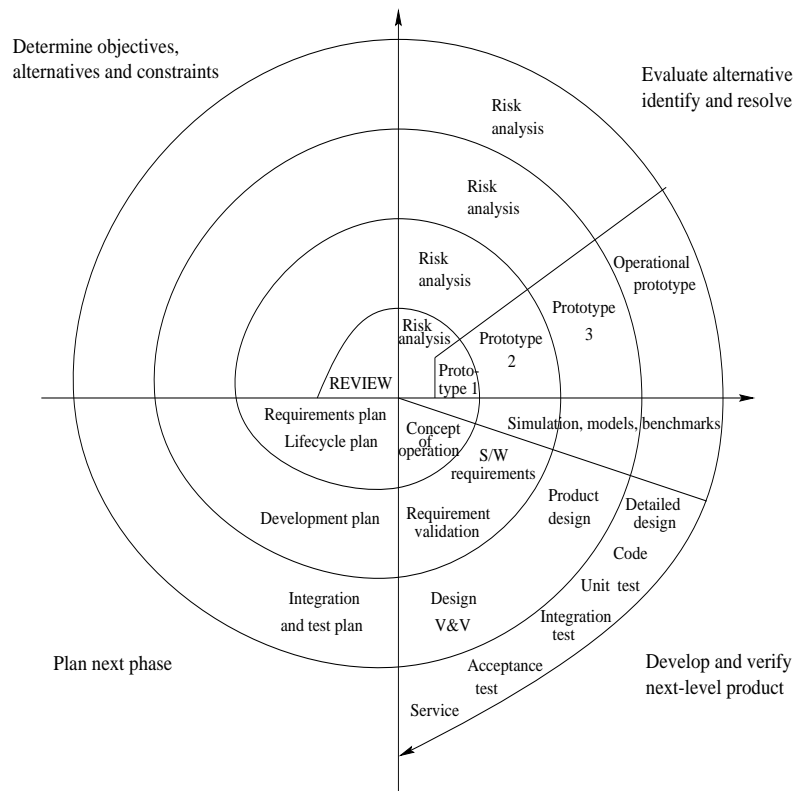


Figure 4.4: Boehm's spiral model of the software process (Sommerville 1995).

A typical cycle would take place in the following manner:

Each cycle starts with identifying the objectives, the alternative means and the constraints of the part of the system that is being elaborated in

this cycle. The next step is to evaluate the alternatives relative to the objectives and constraints defined in the previous step. This is where the risks are analyzed. What should be done in the next step depends on the results of the risk analysis in the previous step. If performance or user interface risks dominates, the next step should be an evolutionary development step. If, on the other hand, program development or interface control risks are dominant, the next step should be a waterfall approach step. Each cycle ends with a review, in which the primary persons or organizations concerned with the product take part.

The main advantage of the spiral model, according to Boehm (1988), is that it includes the good characteristics of other models and their difficulties are handled by its risk-driven approach. It also focuses on early error elimination and definition of quality goals. A problem can be that it requires expertise on risk evaluation (Floyd et al. 1989). Boehm (1988) states that it also needs further development to make sure that all participants are operating in a consistent context.

### 4.3 System development paradigms

One way of trying to understand why different models handle user participation as they do, is to examine on what basis the models have been developed. One such basis is the development paradigms<sup>1</sup> that Dahlbom and Mathiassen (1997) talk about in the book *Computers in Context*. This chapter has so far given a short description of the main features about the waterfall model, prototyping and the spiral model. In this section I look at how the three models fit into the development paradigms described in Dahlbom and Mathiassen's book. I will discuss how this has affected the way the models handle user participation in the development process.

#### 4.3.1 Construction and evolution

Dahlbom and Mathiassen (1997) describe three different paradigms in their book, but I will only concentrate on two of them. The first is the construction paradigm, where the complexity of the problem is the main focus. Processes following the construction paradigm principally take form of a top-down process. In this process the problem is assumed to

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<sup>1</sup>Kuhn (1996) uses the word paradigm to mean the model that scientists hold about a particular area of knowledge. Another definition is the one found in Merriam-Webster (2000) which says that a paradigm is a philosophical and theoretical framework of a scientific school or discipline within which theories, laws, and generalizations and the experiments performed in support of them are formulated.



be well defined and it starts by analyzing the problem. What problem solving strategy to use is the next decision to be made. The final step in the process is the structuration of the solution. The construction process is specification driven, in that the description and analysis of the problem results in a requirements specification which is followed rather strictly.

If we consider the waterfall model in light of the construction paradigm, we can see that it fits rather well. It is a typical specification or document driven approach, which handles problems with high complexity in a rational top-down process.

The second paradigm is the evolution paradigm, which focuses on the uncertainty in a situation. This focus suggests an experimental, rather than an analytical, approach for solving the problem at hand. The *try-and-fail* method is considered to be a constructive way of reducing the uncertainty, since errors are regarded as a possibility for learning and to enhance existing solutions. The system developers that make use of the evolution paradigm, spend more time on identifying and experimenting with possible solutions than on analyzing the problem. The users are a participating actor in this paradigm.

Prototyping plays a central role in the evolution paradigm. It is an experimental way of solving problems with high uncertainty. As mentioned earlier in the description of prototypes, the users are active participants in the development process, which supports one of the features with the evolution paradigm.

### 4.3.2 What about the spiral model?

The spiral model does not seem to fit within the description of neither the construction nor the evolution paradigm, instead it has a few features of both.

The construction paradigm, and with it the waterfall model, deals with problems with high complexity. The evolution paradigm, and thereby prototyping, on the other hand deals with problems with high uncertainty. But what if it is a high degree of both complexity and uncertainty, which is very often the case?

The *Principle of limited reduction* expressed in an article by Mathiassen et al. (1995) deals with exactly this problem:

Relying on analytical behavior to reduce complexity introduces new sources of uncertainty requiring experimental countermeasures. Correspondingly, relying on experimental beha-

vior to reduce uncertainty introduces new sources of complexity requiring analytical countermeasures.

The principle states that the factors, complexity and uncertainty, are not independent. You can not lower one factor without affecting the other in the wrong direction. In connection with the discussion of the construction and the evolution paradigm, the principle promotes a mixed approach for software development. The spiral model is one such mixed approach, which attempts to combine specialized approaches, like the waterfall model and prototyping, during a development process (Mathiassen et al. 1995). This is illustrated in figure 4.5.

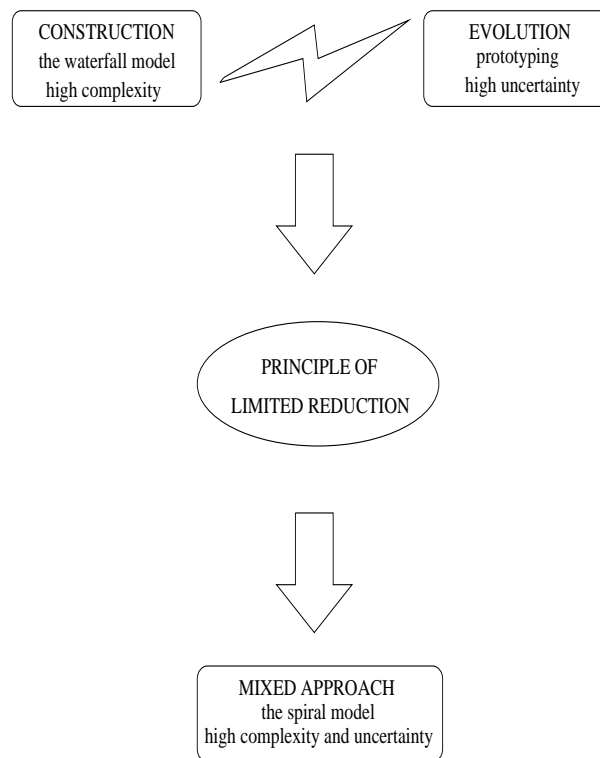


Figure 4.5: Illustration of the Principle of limited reduction's influence on the differences between the construction paradigm and the evolution paradigm.

## 4.4 The models' impact on user participation

What does the discussion in the previous section mean for user participation? It gives us a starting point for discussing why the different system development models handle user participation as they do. One reason

for their different ways of handling this issue, are the assumptions they are developed upon.

#### 4.4.1 The impact of period and paradigm

As we have seen with the waterfall model it was developed according to the construction paradigm in the 1950s and 1960s. User participation was not a hot subject in this period. Most users were in fact programmers or engineers themselves (Grudin 1991). The systems were developed for the developers' own use or for other technically competent persons. The developers did not believe there was a need for user participation.

Prototyping, on the other hand, was kind of a response to the limitations of specifying approaches (Mathiassen et al. 1995), like the waterfall model. Prototyping came under discussion in the late 1970s (Budde et al. 1991) and many of its features have, as we have seen, their basis in the evolutionary paradigm. User participation has also been on the agenda since the late 1970s, which may have affected the way prototyping handles this issue. The users are much more active in the prototyping approach than in the waterfall approach.

As a mixture of both specifying models and evolutionary models, the spiral model was developed in the 1980s. Now user participation was not just on the agenda, but it was beginning to become a subject on the research agenda. The system developers and other technically competent persons were not the only users anymore. This might have influenced how the spiral model deals with user participation.

#### 4.4.2 Challenges and problems

So far I have tried to make a foundation for a discussion of users as participating actors in the system development process. Three development models have been described, both in the light of their content and of the context in which they were developed. The following discussion tries to examine different challenges and problems arising when users take part in the development process. The foundation serves as a basis when I try to explain how the three models deal with these challenges and problems.

##### **Communication between developers and users**

Cooperation between users and developers requires communication. This is one of the main difficulties in a development process, because the

two actors do not always understand each other. When users try to describe how they do things today and what system they want, the developers often do not have the required knowledge to fully understand what they are talking about. The same thing apply when developers try to explain something to the users. To solve this communication conflict, it is important to make sure that the actors communicate at the same level. There is a need for braking the borders between developers and users (Ehn 1993). Figure 4.6 is an illustration of this issue.

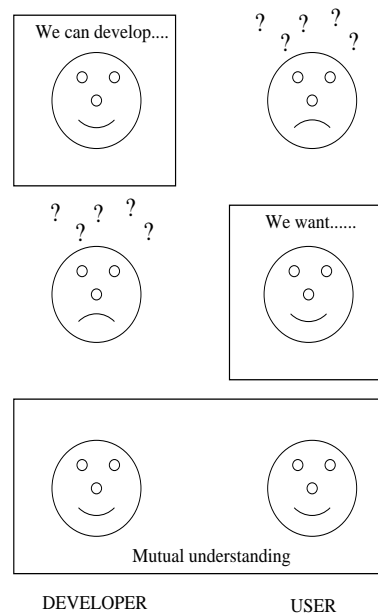


Figure 4.6: In order to develop the system that the users need, the developers and users have to understand each other.

In a book by Bråten (1983), about the conditions of the dialog in the computer society, the author talks about having *model monopoly* and being *model strong* or *model weak*<sup>2</sup>. These terms help describe the situation discussed above, when the actors of a development process do not understand each other.

Having model monopoly means having control in a situation by virtue of an autocrat perspective. You think and speak in only one perspective's terms and premises. This is a situation that may arise if developers do not open for the users' perspective.

Being model strong means that one actor is rich on relevant conceptions and ideas, which reflect his own premises. In this way the area of

<sup>2</sup>The terms model monopoly, model strong and model weak are translated from Norwegian into English.

concern gets delimited or presupposed. The other actors then appear model weak, in that they are poor on such symbolic resources of their own in relation to the area of concern. The conversation happens on the premises of the model strong.

This is exactly what is important to avoid in the case of users and developers trying to communicate. The developers are often the model strong in a development process, because the focus is on technical solutions. This is an area of concern which developers, in contrast to the users, are familiar with. If we look at it from the other side though, where the user perspective dominates, it is the users who are the model strong.

One way to overcome the problem of not understanding each other, is to make sure that both developers and users play the same *language game* (Ehn 1993). To use language is to participate in language games. To learn how to play this game you need to learn its set of rules. In our situation the users are playing their language game, while the developers are playing theirs. To understand each other they need to learn the rules of each others games. There is a good chance to learn and understand new language games, because of family resemblance to other language games that we already know how to play.

The interesting question is how the three models described earlier in this chapter handle the problem of communication between users and developers. Do any of them open for playing the same language game? Of the three models, I believe prototyping and the spiral model are the models which handles this problem best. In the waterfall model it is essentially prepared for little user participation. The developers only cooperate with the users when collecting system requirements. This is often a question-answer process, with little chance of learning each others language games. The developers appear as the model strong and little is done to break down their model monopoly.

In prototyping the possibilities for users and developers to understand each other are much better. It is easier to explain or understand a feature in a system or a work practice, when you have something concrete to look at and use, like a prototype. Usually there are also several rounds with new prototypes in a prototyping development process, which gives the actors better time to learn from each other.

Ehn (1993) describes a project, called the UTOPIA<sup>3</sup> project, where the developers and users had communication problems. This Scandinavian research project was started in 1981 and focused on the trade-union-based design of, and training in, computer technology and work organ-

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<sup>3</sup>UTOPIA is an acronym for Training, Technology, and Products from a Quality of Work Perspective.

ization. The developers were facing serious difficulties when trying to communicate with the users through traditional approaches like data or information flows. But as they started using prototypes as a basis for communication, the situation improved drastically.

The same arguments as those for prototyping applies to the spiral model, since it makes use of prototypes during the development process. The difference might be that the spiral model gives a more structured way of learning from each other. There are several rounds of reviews, where both users and developers shall take part. More documents are also produced, which may help the actors to remember what they have agreed upon in earlier steps.

### Many different users

Another challenge facing the developers is to align the users' wishes and demands, when there are several different users of the future system (illustrated in figure 4.7). Sometimes the users are not even located at the same office. Work practices are usually quite different from one office to another.

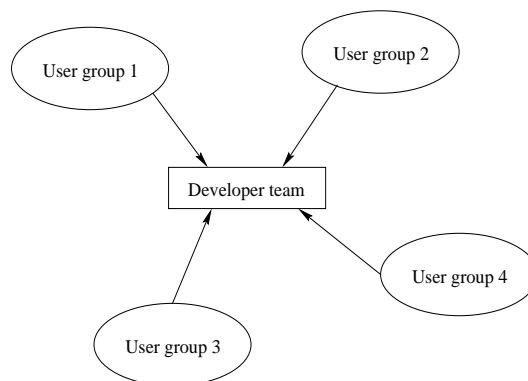


Figure 4.7: The developers have to align wishes and demands from the different user groups.

Much of the above discussion about communication problems between developers and users also apply for this issue. The developers still have to communicate with the users. And the more users, the more difficult to communicate with all of them.

When dealing with many different users, the requirements will probably change more often than when dealing with just a few users. I believe this risk is best handled by the spiral model. This is an approach that analyzes and takes care of risks that originate throughout the development

process. The waterfall model, in contrast, is a more rigid approach and it is very expensive to go back and change decisions made in previous phases.

Prototyping could also be a good way of aligning different users' wishes and demands. The developers could show one user group a prototype and adjust it to their needs. Then they could show the adjusted prototype to another user group and see if it fits their needs. This way the developers do not start from scratch every time they talk to a new user group. It is also easier for the users to see if other users do things differently when they have a prototype that the other users have tested.

Solberg et al. (2000) describe a system, called BL96, which is used by the Norwegian police departments. Prototypes played a central role in the development of this system, which is used by several different user groups. In fact, prototypes helped align the different users' wishes and demands. The problem of different user groups were solved by having representatives for the users cooperating in a group. Based on different prototypes, this helped the developers with the specifications of the system.

### **The question of product ownership**

The third problem I am going to discuss is the question of product ownership. This is not a discussion about legal ownership, but more about how the users relate to the product they are about to get.

Users often show resistance to new products. They are used to their way of doing things and do not always welcome changes to their work practice. One reason for this could be that they do not feel any connection with the new products. They feel it is something that is pushed upon them. This is a very good reason for letting users participate in the development process.

Braa (1995) states that users usually are invited into the discussion when decisions are already made. This is not a good way of handling user participation. The users will not feel more connected to the product, unless they take part in the decision making process. The developers must make certain the decision making process is transparent and explicit, in order to enable users to be actual participants in the development process (ibid.).

To make the users more connected to their future system, there is thus a need to make them a part of the entire development process. It is not enough to just let them answer a few questions or to show them results based on decisions they have not participated in. The waterfall model only supports participation of users early in the process as the

requirements are gathered.

With prototyping the users can see that decisions they are a part of making, are taken into consideration in the prototypes. This also apply for the spiral model, since prototyping is a part of this model. The spiral model also ends each round of the process with a review, where the central persons, like the users, or organizations concerned with the product take part (Boehm 1988).

## 4.5 Development of services for wireless terminals

This thesis is particularly concerned with mobility and wireless communication services. Having discussed traditional system development and user participation earlier in this chapter I think it is about time to get back to the subject of mobility. A trend we can see the beginning of today, and what will be more and more dominating in the future, is that wireless terminals with their services are getting more and more popular. People are using mobile phones, wireless computers and PDAs in an increasing manner. The rest of this section is looks at the similarities and differences between developing systems for wireless and traditional fixed plug terminals.

One of the first subjects I discussed in this chapter was the framework based on Grudin's (1994) article *Groupware and social dynamics: eight challenges for developers*. In this section I will make use of this framework as I try to find out how the development of wireless services fits into the way traditional development is done. Another article called *The development of interactive systems: bridging the gaps between developers and users* by Grudin (1991) will also serve as reference material in the following discussion.

The second article mentioned above categorizes system development into three different paradigms for software project development:

1. Contract development.
2. Product development (also referred to as off-the-shelf development).
3. In-house development.

The purpose of this section is to bring the subject of wireless system development into the discussion of traditional system development. I suggest a placing of wireless services in the software universe promoted by Grudin and compare wireless system development versus the three paradigms mentioned above, to find out what paradigm best fits wireless system development of today.



### 4.5.1 Wireless services in the software universe

This section presents where in the software universe the development of wireless services belongs, based on what I have experienced during my research. The presentation of my case studies later in the thesis will show that I have experience with a WAP service for people traveling with public transport and a wireless intranet for employees in a consultancy firm. I have also been using several wireless services on my free time.

The software universe presented by Grudin (1994) divides the software systems into three categories: micro- and mini applications for single users, groupware systems for groups of users and large mainframe systems for organizations. My experience with wireless services makes me want to categorize them as micro- and mini applications. Many of the programs developed for mobile devices are for personal use, like the calendar function on PDAs, games on both mobile phones and PDAs, and electronic address books. In fact, most of the mobile services offered today look a lot like services offered on the Internet, which are services for individuals.

Figure 4.8 is an illustration of my suggestion of where to place the wireless services in the universe of software systems.

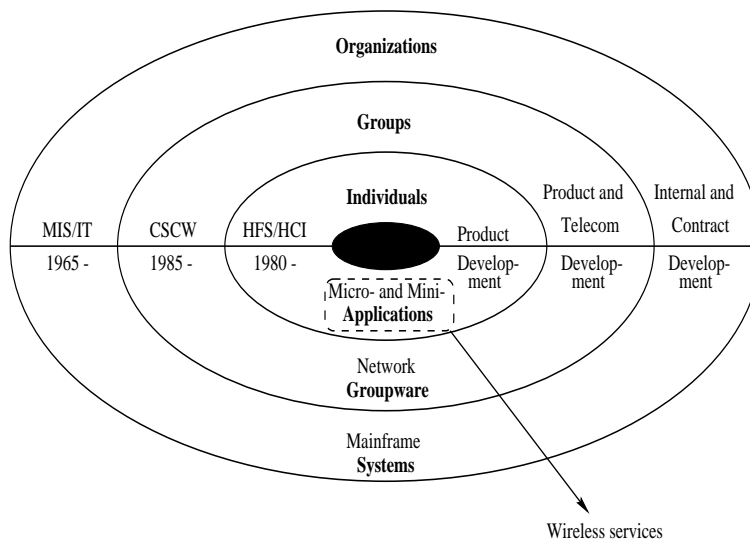


Figure 4.8: The placement of wireless services in the software universe.

### 4.5.2 Wireless services in relation to the paradigms

The second article written by Grudin divides system development into the three paradigms mentioned earlier. The paradigms and what characterizes them are listed below.

*Contract development.* The user organization is known from the outset and the development organization is identified after a contract is awarded. In other words, the users are known before the developers. The clearest case of this paradigm is competitive bidding.

*Product or off-the-shelf development.* The developers are known from the outset, but users are often unknown until the product is marketed. There is some idea of the users since the products are aiming at certain markets. The important facet of this kind of development is the uncertainty about the eventual user population.

*In-house development.* Both users and developers are known from the outset. The degree of initial identification is very high. This paradigm also occurs in custom development, where an external developer is engaged from the start.

The paradigms put forward by Grudin are based on when users and developers are identified during a software development project. Figure 4.9 illustrates when this identification occurs in the three different development paradigms.

The wireless services developed so far, at least the ones I have experience with, seem to fit into Grudin's (1991) product or off-the-shelf development paradigm. Most of these services are provided by different companies to every person with a device capable of accessing their services. This can be news, games, e-mail or stock information. In these cases the users are unknown from the outset, even though the service providers are aiming at certain market segments. Because the area of mobile informatics still is immature it is hard to know who exactly the users will be. Many of the companies providing off-the-shelf products could probably use the quote below as a slogan.

*With a large number of possible users, a product can do very well if only a fraction of the market finds it acceptable.*

— Grudin (1991)

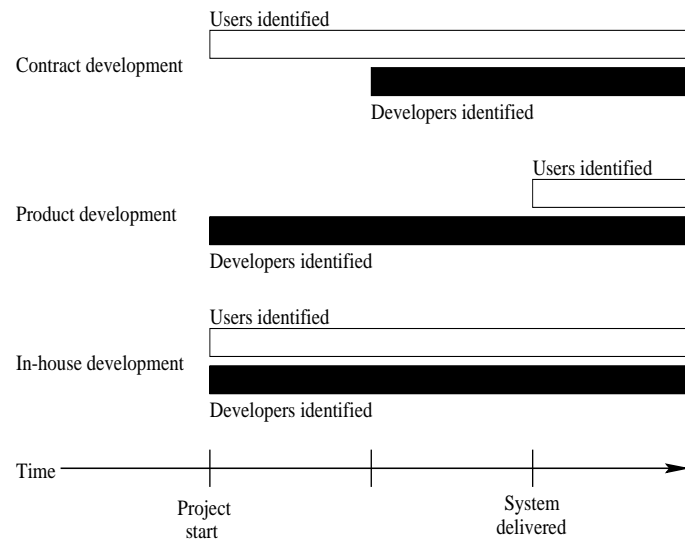


Figure 4.9: Project time lines showing the time of user and developer identification.

## 4.6 Summarizing the chapter

In this chapter I have described the waterfall model, prototyping and the spiral model, in order to discuss how these models handle challenges and problems arising when users of a future system participate in the development process.

The models, and the waterfall model and prototyping in particular, are based on two very different development paradigms. This may have affected the way the models handle user participation.

When the waterfall model is used as a model for system development, the development process has a starting point with little focus on user participation. The problems and challenges discussed in this chapter are poorly solved by this model. Users are not involved in the process as much as required to manage these problems and challenges in a satisfying manner.

Prototyping has a different starting point when it comes to user participation. This model is based on the evolution paradigm, which opens for user participation through the entire process. As we have seen in the previous discussion, this model handles many of the user participation problems with good care. The problem with this model is its lack of structure and control (Braa 1995). Usually the users or the management in the developer organization like to see progress in a process. This is quite difficult in prototyping, because little is documented. The proto-

types are the specifications.

The spiral model seem to handle user participation best of these three models. It combines the good features of both the waterfall model and prototyping. This is not the same as saying this model handles user participation best of *all* models. Such a model does not even seem to exist, since there still are so many difficulties of having users participate in the development process. Still it is an absolute need for them to be part of it. Turning back to the spiral model, we can say that it is much more structured than prototyping and much less strict than the waterfall model. By using prototyping and at the same time making the process visible through documentation, the spiral model offers a good basis for user participation.

The last subject discussed in this chapter was how developing wireless services fitted into the way traditional systems have been developed. It seems that many of the wireless services provided so far are pure "translations" of more traditional services. Examples are news for the PDA, games suited for mobile devices and Outlook for PDAs. These are product developed services, where there has been little user participation in the development process. Even though mobile informatics is gaining popularity, a standard model of developing wireless services has not been manifested yet. I believe the developers in a large degree use the "try-and-fail"-method, so they can get to know the technology and learn how things work and are done.

## Chapter 5

# Wireless technology

This chapter provides an overview of the history of mobile communication and its future development. From the early days of the radio communication at sea and to today's small wireless terminals, there has been a trend towards more and more sophisticated services. The ever increasing number of Internet and wireless communication subscribers, tells us that people need and want multimedia communication and instant access to information (Nilsson 1999b). Where we are today is just a step on the way in the evolution of wireless communication.

Part of this evolution is the Wireless Application Protocol (WAP), and its intention is to provide users with various Internet-based services while they are on the move. The reason for why I have chosen to put focus on WAP in this chapter, among other mobility issues, is because of the major role WAP plays in the case studies presented later in the thesis. As we will see in chapter 6 I have investigated a WAP service offered by a company called Trafikanten, I have talked to a person with experience in developing WAP services and I have actually been part of a development project at a consultancy firm called Ementor, where a WAP intranet were supposed to be developed.

### 5.1 A trend towards wireless systems

During the last years it has been a constant evolution of computer systems. The first machines were large, single user machines, where one had to be physically located at the machines to use them (Katz 1994). These machines ran single user operating systems and the users were collocated in time and space. Figure 5.1 is an illustration of the evolution described by Katz (1994).

The next step in the evolution was the introduction of batch processing,

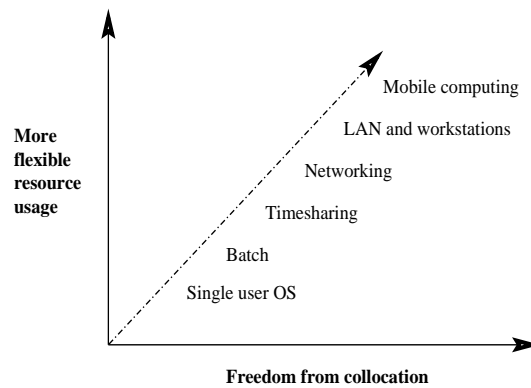


Figure 5.1: The evolution of computer systems based on freedom from collocation and more flexible resource usage (Katz 1994).

which freed the user in time. The users still had to be located with the computer, but they did not have to wait until the machine was free to do their work. Following batch processing was timesharing. This enabled many users to simultaneously share computer resources and they did not have to be physically located with the actual machine. Distributed timesharing systems, or networking, was the next extension to the evolution. But even though users could be spread across a wider geographically area, there were still limitations to overcome.

Through LAN and workstations many of the limitations were solved. Users now had user-dedicated resources, like dedicated workstations, and shared resources, like servers and printers, which enabled them to be dispersed over a wide area.

This is what we have seen happen until today. The next step in making the users even more independent from the computer environment, which we already see the start of, is wireless computing. The users will then be able to access system's resources anytime and anywhere as long as they are located within the range of the wireless communication's infrastructure.

### 5.1.1 What is mobility?

As we have seen, the evolution of computer systems is moving towards wireless and mobile systems. But what is mobility and is wireless something else than mobility? Below I describe what I mean with mobility in this thesis, but first a few words about the phrase wireless and how it is related to mobility. The relation can be simply stated as wireless enables mobility. In that I mean that having access to a wireless terminal, like a

PDA, makes it possible to use the systems on that terminal while being on the move. You are not bound to the terminal at one place, but can move around still using the terminal. On the other hand, one can not say that to be able to be mobile one have to have wireless terminals. This is something that will be explained below.

There are several attempts to categorize and define the phenomenon mobility (for example, see ?), but I have chosen to categorize it into three different types of mobility, *personal* , *application* and *terminal mobility* (van Thanh 1997).

*Personal mobility* is when the person is the one who is moving around. He can access services from different locations, for example from his home or office, or he can access services on a terminal he brings with him. In the context of computer science, personal mobility is the ability to move around and still have access to different services.

*Application mobility* is when a computer program or service can be reached independent of net and terminal. This is what we see on the World Wide Web (WWW) today. We use different computers, but can access the same services on each of them.

*Terminal mobility* is when we actually can take the device with us. The device can be used independent of a fixed plug. A typical example is the mobile phone, which we bring with us and use everywhere.

To obtain personal mobility one need to have one or both of the other types of mobility. In other words, application and terminal mobility makes personal mobility possible. This is also illustrated in figure 5.2. Terminal mobility requires that the terminal is wireless, but application mobility can be achieved on both fixed plug and wireless terminals. A good example is the Internet. All applications on the Internet have application mobility because one can reach them independent of what terminal you use, as long as the terminal is connected to the Internet. This means that for a person to be mobile, or to have personal mobility, he does not have to use a wireless terminal, but can achieve it through application mobility. The person can then *move* from one place to another and in that sense be mobile and still use different applications.

One way to illustrate personal mobility is to see how a person uses a phone box and a mobile phone. The first type of phone is located at fixed places and is therefore not mobile, but the second is wireless and can be used independent of a fixed plug. What they have in common is that they both enable the person who uses them to have personal mobility. He can either go from one phone box to another and use exactly the

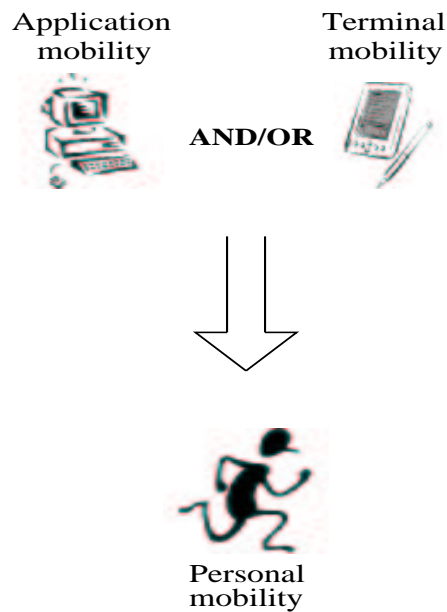


Figure 5.2: Application mobility and terminal mobility make personal mobility possible.

same service at both places or he can use his mobile phone wherever he is. In both situations he is mobile.

## 5.2 Wireless communication

I start this section by presenting some main events in the history of wireless or mobile communication. Following this presentation is a brief discussion of what is going on in the development of wireless communication today and what is expected to happen in the near future.

### 5.2.1 History

Norway has always been one of the leading countries in the development of wireless communication and I will base most of this section on an article called *The history of mobile communication in Norway* by Grimstveit and Myhre (1995). Although this article describes the history in Norway, I believe it can be adapted in other countries with a wireless communication history.

One of the earliest applications of radio communication was maritime communication using Morse telegraphy. This was around the year 1900,



when the first ships installed radio telegraphy stations. The intentions were safety and better management of ships, but later it became the most important way of communicating.

Following the Morse technique was the introduction of VHF<sup>1</sup> in the 1950s, which was introduced for short distance communication with ships. When making phone calls carried on VHF you get manually connected through the telephone network. The communication at sea was now established and land wireless communication was the next step to be introduced.

By developing the NMT<sup>2</sup> system in the 1970s, Scandinavia established its front position in the development of land wireless communication. Actually, the NMT project is internationally considered as pioneering and has served as a model for mobile telephone services in more than 40 other countries (Grimstveit and Myhre 1995). One of the success factors of NMT was its high functionality. Multi-country usage and hand over between base stations during calls are examples of functions. In 1982 a roaming function was available, making it possible to use the phone when visiting another Nordic country.

In the late 1980s and early 1990s the development of the second generation (2G) digital cellular standards took place (Nilsson 1999a). During the eighties the need for a set of common standards for a pan European wireless communication system emerged. The result of this was the GSM<sup>3</sup> system, which was in commercial operation for the first time in 1991. GSM soon evolved into the leading global standard in terms of number of subscribers and area of coverage (ibid). In the USA they developed a standard called TDMA/136<sup>4</sup>, which also is a 2G standard for digital cellular networks.

The digital system GSM is much like NMT, in a broader sense. It opened up for several competing operators in each country, and new services like data and short message communication was offered. The system also has roaming capabilities with a large number of countries around the world.

What the 2G standards essentially define is a system that provides mobile end-users with circuit-switched telephony services. In the next section I will describe how further development of the 2G standards will result in 3G standards, and what services the mobile users will be presented with in the near future.

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<sup>1</sup>Very High Frequency

<sup>2</sup>Nordic Mobile Telephone

<sup>3</sup>Global System for Mobile Communication

<sup>4</sup>Time Division Multiple Access

### 5.2.2 Wireless communication standards

What we can see the start of today is a change from traditional person-to-person speech communication to personal mobile multimedia services and terminals (Grimstveit and Myhre 1995). This change will proceed gradually over time, but it will not take long before communication services are instantly available.

For this change to be successful there need to be an efficient migration path from second-generation to third-generation standards (Nilsson 1999a). As we saw in the previous section there is a long history of development behind what is offered in wireless communication today. Standards and techniques build on each other and that is the way development will be done in the future too. There is nothing exceptional about where we stand today. It is just that new technology and knowledge is available to us and we use that to further develop what we already have. An example is the major cellular standards, like GSM and TDMA/136, which are being further developed to provide 3G capabilities (Nilsson 1999a). As a result of this constant development, one of the most important requirements for 3G systems is that it must have the ability to inter work with existing networks. This means that today's circuit-switched networks will coexist with 3G packet-switched networks for some time, and the two types of networks will be interconnected through gateways that offer common mobility control.

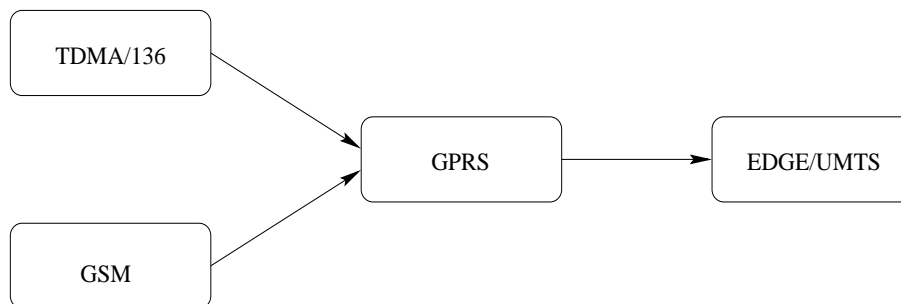


Figure 5.3: An illustration of the convergence of TDMA/136 and GSM.

For the two systems GSM and TDMA/136 a convergence toward 3G systems starts with GPRS<sup>5</sup> which creates a common core network architecture and shares network components. GPRS is a packet-switched service that allows full mobility and wide-area coverage (Grimstveit and Myhre 1995). The next step is EDGE<sup>6</sup> and UMTS<sup>7</sup>, which unify the ra-

<sup>5</sup>General Packet Radio Services

<sup>6</sup>Enhanced Data rates for GSM and TDMA/136 Evolution

<sup>7</sup>Universal Mobile Telecommunications System

dio network and terminals. Figure 5.3 illustrates this convergence. I am not going to describe the details of this convergence, but I refer to the World Wide Web and the articles *Toward third-generation mobile multimedia communication* by Nilsson (1999b) and *Third-generation radio access standards* by Nilsson (1999a) for further information on the subject.

The first article mentioned above claim that the expected number of wireless communication subscribers will reach about 1 billion in 2003/2004. There will be the same number of Internet subscribers, and of these more than 350 million will be wireless Internet subscribers. With so many users in prospect, with the expectations they will have, the development of 3G standards is faced with several challenges. There must be an efficient real-time quality of service and packet-switching techniques must provide reliable, wide-area communication (Nilsson 1999b). Mobile telephony coverage and the associated user base must be combined with the Internet and other multimedia applications (Nilsson 1999a).

The list below mentions some highly valued capabilities which we can expect 3G systems to provide (Grimstveit and Myhre 1995). These capabilities are also illustrated in figure 5.4.

- Full range of services, with narrowband for voice communication and wideband for multimedia communication.
- Support for high speed packet data.
- Unified messaging services.
- Real-time audio/video applications.
- Mobile e-commerce applications, making it possible to reserve tickets, make banking transactions, pay parking fees etc.
- Mobile office applications.

In the next section I discuss the Wireless Application Protocol, or WAP for short. This is an example of one of the new architectures offered today for wireless terminals enabling new types of services. The reason that I discuss the WAP standard is that it is the start of a whole new set of services offered in wireless communication. The technology is not new, but the way it is used is. WAP is an example of how data can be adapted to wireless or mobile environments and exemplifies an end-to-end wireless standard within the client/server architecture (Grimstveit and Myhre 1995).

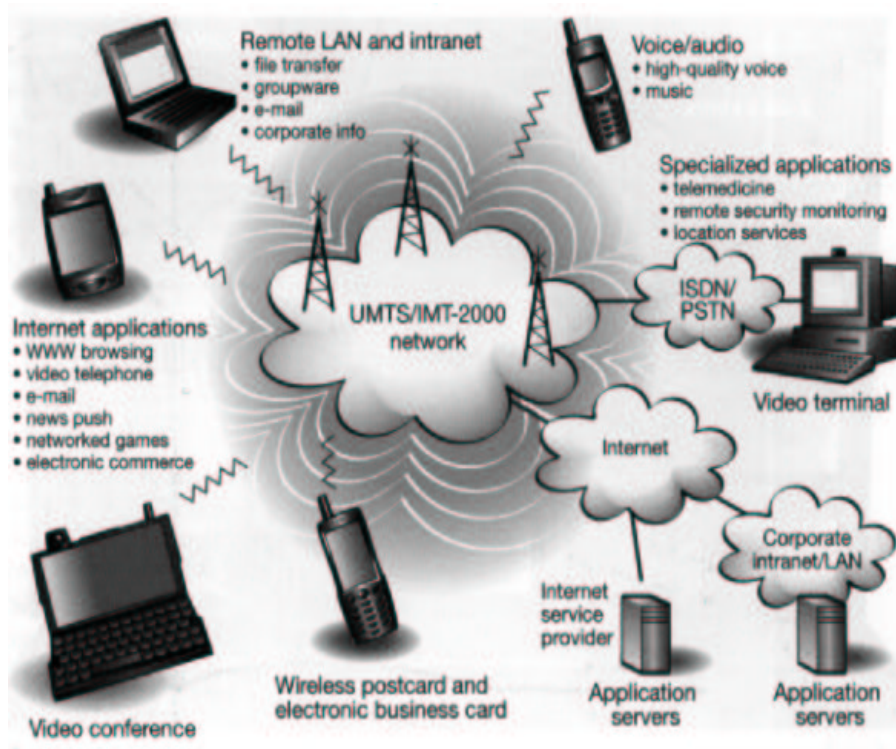


Figure 5.4: An illustration of highly valued capabilities in 3G systems.

### 5.3 WAP - wireless application protocol

As we have seen so far, there is a constant development of wireless communication systems. New technologies are being developed and used, and the users are constantly faced with new services.

Several articles (Pearce 1999, Alcatel 1999, Diaz 1998, WAPForum 1999) explain what the Wireless Application Protocol is. Even though they use different words, there is an agreement on the meaning. WAP is a protocol, an open-global specification whose purpose is to standardize the way a wireless device can communicate and easily access information over a cellular network. The goal is to offer a web-like experience to wireless devices with limited display and data capabilities (Pearce 1999, Diaz 1998).

### 5.3.1 The WAP forum

The WAP Forum was formed in mid 1997 by Nokia, Ericsson, Motorola and Phone.com after a US network operator, Omnipoint, recommended that different vendors got together to define a common standard for wireless information services. The reason for this recommendation was that Omnipoint had received several different responses after issuing a tender for the supply of wireless information services (Lifestreams 1999).

Today, less than four years after the start up, the WAP Forum has over 200 members and together they have agreed upon a de-facto standard for wireless information and telephony services on wireless devices.

The philosophy which the WAP approach is based upon is best expressed by one of the representatives on the board of the WAP Forum:

*The philosophy behind WAP's approach is to utilize as few resources as possible on the handheld device and compensate for the constraints of the device by enriching the functionality of the network.*

*- A WAP Forum board member (Lifestreams 1999)*

### 5.3.2 Structure

Figure 5.5 shows a comparison between the WAP protocol stack and the Internet protocol stack (Erlandson and Ocklind 1998). To describe the content of these stacks is out of the scope of this thesis. For a full description of the WAP stack I refer to the standards specifications which can be found at <http://www.wapforum.com>. Information about the Internet stack can be found on the World Wide Web or in numerous books.

To display WAP content on a wireless device you need to specify the content in a certain language called WML. WML is a mark-up language defined by XML. WML is simply the wireless version of HTML used on the Internet.

The display of a wireless terminal has limited size and the basic unit of WAP content to display is called a *card*. Such a card can be thought of as one screen of information or one part of a fill-in form. For an entire application or service you might need several cards. Such a collection of cards is defined as a *deck* (Diaz 1998).

WAP is based on and uses Internet standards like XML, UDP and HTTP, but over mobile networks the Internet standards become inefficient and

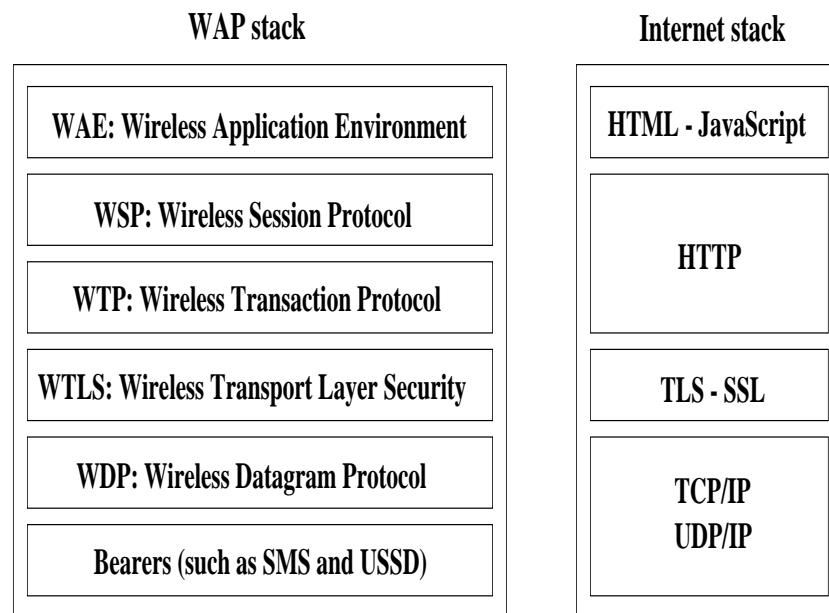


Figure 5.5: A comparison of the different layers of the WAP protocol stack and the Internet stack.

as a result wireless services are slow, costly and difficult to use (Alcatel 1999). WAP is an optimization which solves the problems of using Internet standards.

### 5.3.3 Communication

The development of WAP follows a client server philosophy and there are two ways of getting content from a server to the WAP client (Diaz 1998). One way is to connect directly to a WAP server. This is illustrated in figure 5.6.

If, on the other hand, the content you are interested in is located on a WEB server, the client need to communicate with the server through a WAP gateway. This gateway is a piece of middleware and translates the WAP request into another protocol, such as HTTP, gets the content and translates the response into a WAP response. This is illustrated in figure 5.7.

Future versions of the Internet standards HTTP, HTML and TCP will hopefully meet the special needs of wireless terminals and can also be supported in the WAP framework, and there will not be need for a WAP gateway (Alcatel 1999).

The problem with displaying Internet content on a WAP device is its

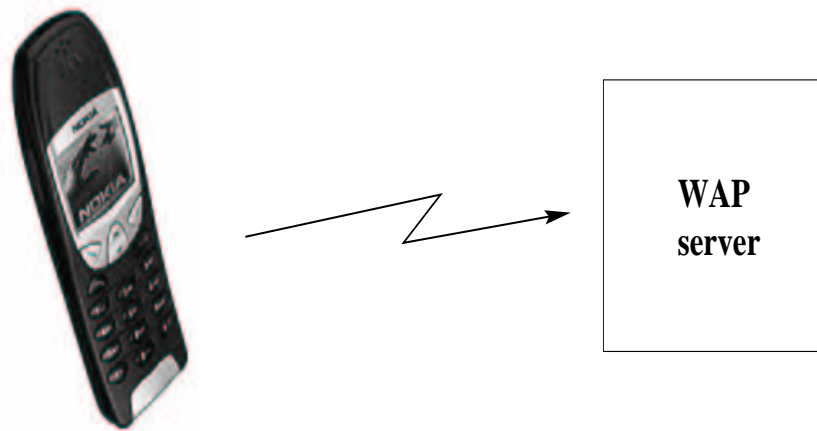


Figure 5.6: A WAP mobile phone can communicate with a WAP server directly.

limited display and resources. That is why WAP content has to be on a special format with rather small files, with no or at least small, simple illustrations.

### 5.3.4 WAP - a failure or success?

When the WAP Forum was formed, WAP soon became a hot subject. It should be a standardized way of linking two of the fastest growing industries of today, the Internet and wireless communication. With the support of major companies in the WAP Forum it was seen as a way to rectify the fact that wireless information services have not been as successful as many network operators expected (Lifestreams 1999). The subject was covered in media and the future users were "promised" the Internet in their hands in the near future.

But now it seems that the excitement over WAP has been tuned down. At least in Norway, it took a long time before the terminals came on the market and when they finally did they did not meet the users' expectations. Lewis (2000) claims that the reason for why WAP has not succeeded is that it failed to co-evolve with the wireless infrastructure. When the evolution of one species depends on the evolution of another, they are coupled together as a co-evolving system (Lewis 2000). Mobile phones and wireless infrastructure is a typical example of such a system. Because of extremely slow progress in 3G, GPRS and other wireless technologies there seems to be little hope for the future of WAP. This is a chicken-and-egg situation where WAP depends on the digital wireless infrastructure to take off and the infrastructure will not be build out as

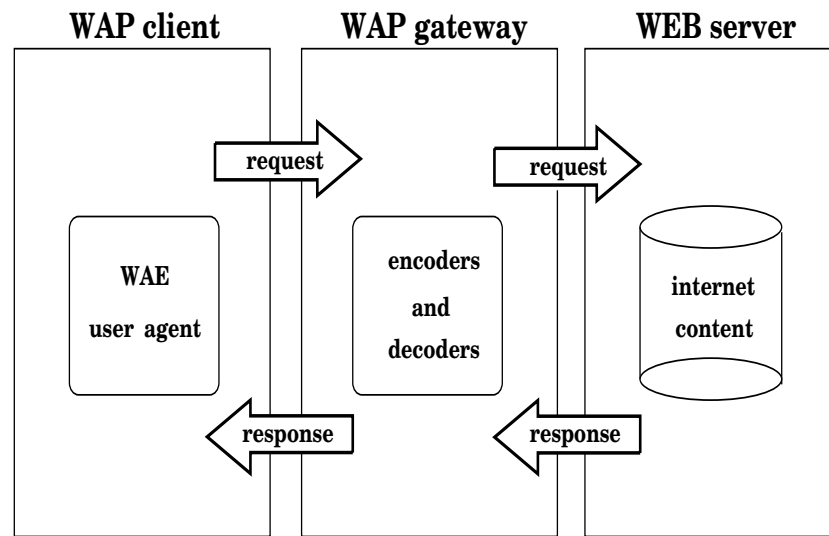


Figure 5.7: A WAP mobile phone can communicate with a WEB server through a WAP gateway.

long as handsets are not in place.

## 5.4 What will the future bring?

Having seen how fast the evolution of wireless communication has been until now, it is hard to know what to expect in the future. The area has gained enormous interest the last years and will probably not be less interesting in the next years. There seems to be an evolution towards a situation where one can be connected to the Internet all the time. We already have fixed plug computers that are connected at all times, but with third generation mobile Internet it will soon be an everyday feature to have our wireless terminals instantly connected to the Internet. Not only will we always be connected, the services we connect to will be much faster to use through the broadband technology that is just around the corner. Until now most services for wireless devices are based on text, but with the broadband technology we will see other types of services where sound and picture will play a central role.

Another trend is that the wireless terminals are getting smaller. The first mobile phones had the size of a briefcase, and now they are small enough to fit into your hand or a small pocket. In addition to getting smaller the terminals also get more integrated. Instead of having one mobile phone and one PDA, one can have an integrated phone and PDA in the same and perhaps more powerful terminal.



## Chapter 6

# The case studies

In this chapter I present my case studies and discuss them in the light of the theory presented in chapter 2. The main case is the one I did at Trafikanten, which is a Norwegian public transport information provider. I have also had contact with a Norwegian consultancy firm, called Ementor, where I have worked myself and had one interview. This is more like a secondary and supporting case, because the knowledge I gained here has contributed to give me an overall understanding of the area I am studying. I will mainly use the results of the Trafikanten case to analyze observations and findings in the light of the applied theory.

I open the chapter with a presentation of Trafikanten, their services and what kind of cooperation I have had with them. A presentation of the case at Ementor follows, with a description of what I have done there and a summary of the interview I had with an employee.

### 6.1 Trafikanten

Trafikanten is a Norwegian company that provide information about public transport in the Oslo area. In addition to distributing and making information available for their customers, they sell different kinds of tickets. There are between 80 and 90 people working for Trafikanten, distributed in three different divisions. One of their goals is to be recognized as a competitive neutral company, which offers information about people's travels - from door to door - in the best way. Figure 6.1 shows a schematic map of the Oslo Underground, a map one can see at each Underground stop.

The company offers several ways to get information about the public transport in Oslo. You can look it up in one of their paper based timetables, contact their call center, visit their center for customer ser-



Figure 6.1: A schematic map of the Oslo Underground.

vice, use their Internet service or WAP service or look at the timetable boards on each station. Figure 6.2 illustrates these services. They also have plans for other ways to offer the users of public transport the right information. Below is a short description of the services they offer today.

- The **WWW service** is the most frequently used service and can be found at [www.trafikanten.no](http://www.trafikanten.no). Here you can type in or choose parameters that fits the trip you are planning and find out how you can get from one point to another as fast as possible with public transportation. You can also find other information, for instance you can download any of their timetables.
- The **WAP service** is offering a limited version of the trip planning service on the Internet. It is a simpler kind of service because of the limited resources you have on a WAP enabled phone. The service can be reached at [wap.trafikanten.no](http://wap.trafikanten.no).
- Trafikanten's **call center** can be reached at a certain telephone number (177 for the time being). By dialing this number you get in contact with an operator that can give you information about the public transport in the area of Oslo.
- **Timetable boards** are located at the different stops. These boards list when the public transport arrives and leaves from the stop. If it is a digitalized board it sometimes informs about delays.

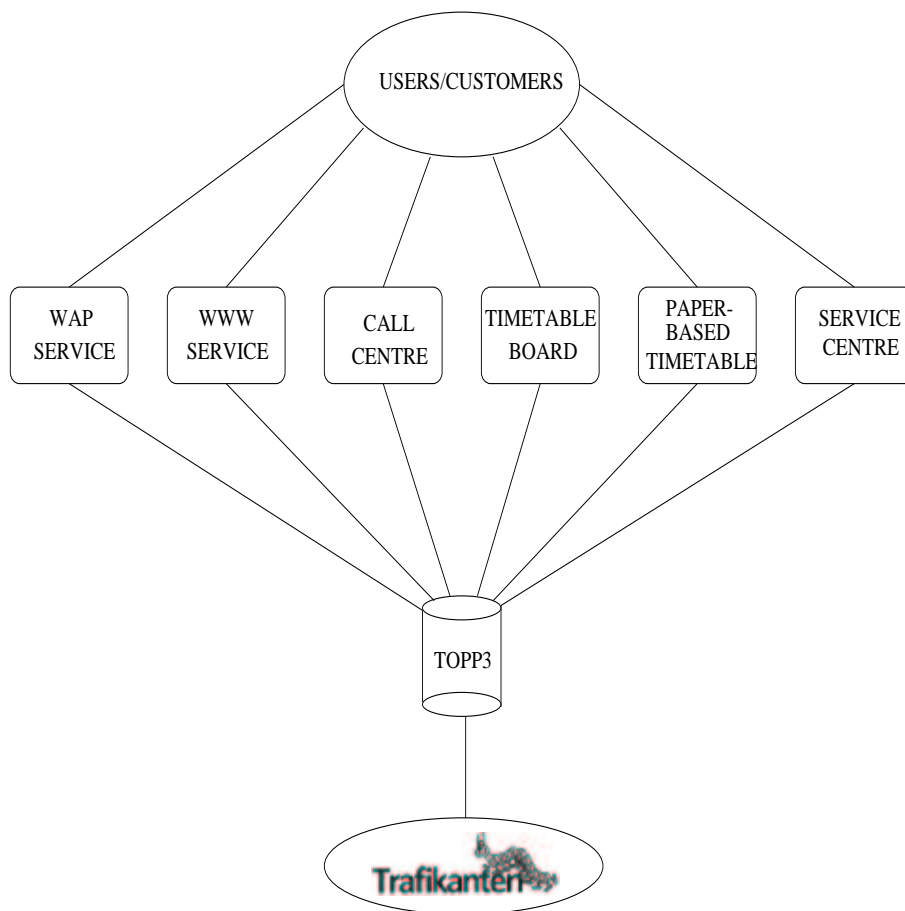


Figure 6.2: An illustration of the organization of Trafikanten. TOPP3 is a database where all the time table information is located.

- **Paper based timetables** are located in small booklets or brochures. You can bring them with you, have one at home or at work etc. These list when a certain public transport leaves from and arrives at different stops.
- The **service center** is a place you can go and get information. Either you can talk to one of the persons working there or you can get different kinds of brochures and timetables.

To be able to offer information of good quality, Trafikanten has to take advantage of the possibilities new technology can give. Their Internet service has been a success and now they want to offer even more services to their users, preferentially electronic services. With the influx of inquiries from the users, they need a larger capacity to handle these

inquiries, but they can not afford more manual operators for their call center service. There are especially two areas which they are planning to get into. The first is a speech recognition system, where you can call a number and communicate with a machine that recognizes what you say. There are a lot of aspects about this system which I will not get into here, because it is out of the scope of this thesis. What I will get more into, on the other hand, is the second area Trafikanten already has set out for. This is the area of wireless technology, more precisely the WAP technology, which is the reason why I got in touch with Trafikanten in the first place.

### **6.1.1 Selected services**

In the further discussion I have chosen to focus on four of the services offered by Trafikanten. These are described in more detail below. I focus only on these four services because I believe one area in which we can see the evolution towards a digital, wireless society is in the transition from paper based systems, through fixed plug computer and telephony systems to systems on wireless devices like a WAP enabled mobile phone.

#### **Paper based timetables**

Paper based timetables can be found in small booklets or brochures distributed by Trafikanten. Figure 6.3 is an example of a timetable. You can either collect them in one of the conveyances for public transport, at operated stops or at the service center. There are different types of booklets suited for people's different needs, but the presentation of the timetables is fairly similar in all booklets. They are presented in tables with the names of the stops and the corresponding departure times.

The paper based timetables differ from all the other services in that they are static. Once a timetable booklet is printed and distributed it can not be changed or updated. When new routes are available and arrival and departure times are changed, new booklets need to be printed and distributed.

#### **Call center service**

To make use of this service you need to call a certain number (for the time being 177). When you do that you can ask an operator different questions about the public transport in the Oslo area. You can ask how to get from and to places, when a particular public transport leaves from

4

Bergkrystallen

Blindern

Mandag - fredag

Bergkrystallen	Lambertseter	Ryen	Brynseng	Helsfyr	Tøyen	Jernbanetorget	Stortinget	Majorstuen	Blindern
0533	0536	0541	0545	0547	0550	0554	0555	—	—
0548	0551	0556	0600	0602	0605	0609	0610	—	—
0603	0606	0611	0615	0617	0620	0624	0625	—	—
0618	0621	0626	0630	0632	0635	0639	0640	0644	0647
33	36	41	45	47	50	54	55	59	02
48	51	56	00	02	05	09	10	14	17
03	06	11	15	17	20	24	25	29	32
18	21	26	30	32	35	39	40	44	47
1733	1736	1741	1745	1747	1750	1754	1755	1759	1802
1748	1751	1756	1800	1802	1805	1809	1810	1814	1817

Se også linje 1 for rutetider til og fra Bergkrystallen!

Stoppesteder

og kjøretider i minutter:

Bergkrystallen	00	Helsfyr	13
Munkelia	01	Ensjø	15
Lambertseter	02	Tøyen	17
Karlsrud	04	Gronland	19
Brattlikollen	05	Jernbanetorget	20
Ryen	07	Stortinget	21
Manglerud	08	Nationaltheatret	22
Høyenhall	10	Majorstuen	26
Brynseng	12	Blindern	28

Figure 6.3: An example of a paper-based timetable.

or arrives at a certain stop, what it costs to travel with public transport in Oslo etc. The service was expected to reach about 1.2 million requests by the end of 2000 (Trafikanten 2000).

It is interesting to study the call center service, because it is a transient service. By that I mean a service in which the information disappears the moment it has been given. The user has to write down or remember the information given, and if he forgets it he has to make the call once more.

### WWW service

The Internet service was launched in 1997 and the use of it has been increasing from the start and still is. The system gives the users instant access to a travel organizer which gives you the fastest route between

every public transport stop stored in Trafikanten's database. During the year 2000 about 1.4 million users will have made use of the WWW service (Trafikanten 2000). You can also retrieve other kinds of information, like facts about Trafikanten, maps, ticket prices and a help page.

The start page of the WWW service is illustrated in figure 6.4.

**Trafikanten**

Trafikk Takst Nyttig Tabeller Trafikanten Hjelp Oslokart

**① Finn reiserute:**  
Mellom stoppesteder

**② Tidspunkt:**  
Fredag 19.01.2001  
Avgang etter kl.:  
Ankomst før kl.:  
14 00

**③ Stoppested:**  
Fra: I  
Til:  
Søk Ny reiserute

Transportmidler ▼

**Velkommen til Trafikanten**  
Du kan legge opp din reiserute direkte gjennom reiseplanleggeren vår. Fyll ut feltene i venstre ramme og klikk "Søk".

**Trafikantens reiseplanlegger omfatter:**  
Sporveiens linjer, Lokaltog i Oslo-området, Flytoget, Flybussen 344, Torp-ekspressen og SL-rutene unntatt: [rute 716 Nesodden-Lysaker](#).

**Søk på adresse!**  
Kjenner du ikke navnet på stoppestedet ditt? – Dersom du skal reise til/fra adresser i Oslo, kan du også søke direkte på adresse. Skriv gatenavnet i til- eller frafeltet når du søker "Mellom stoppesteder". Du skal ikke skrive inn gatenumret, det vil du få valg om etter at du har klikket "Søk".

**Sporveien treffer tiltak**  
Etter ulykken på trikken 16.01.01 har sporvognsdivisjonen bestemt at svensketrikkene midlertidig bare vil bli kjørt som enkeltvogner. [Les mer...](#)

**Byrådet har godkjent takstene**  
Sporveiens forslag til takster (priser) fra 1. mars er nå godkjent. Det blir en takstøkning på 3,9%. Enkeltbilletten endres ikke. [Les mer](#)

**Møtelokale**  
Byens mest sentrale møtelokale finner du på Trafikanten! [Mer..](#)

**Sporveismuseet**  
Er du bypatriot og interessert i historie og sporveisdrift? – Besøk Sporveismuseet. Museet har en vognhall i Garderveien 5 på Majorstuen der det holder åpent søndag og mandag 12–15. Klikk på bildet for mer info.

**Alle stoppesteder** [Klikk her](#) for å se liste med alle stoppesteder i Oslo og Akershus.

**Trafikanten på wap**  
[mer om wap.trafikanten.no](#)

Figure 6.4: An illustration of the start page of the WWW service offered by Trafikanten.

### WAP service

This service makes it possible for users to connect to Trafikanten's Internet site through a WAP enabled terminal. The start page of the service is illustrated in figure 6.5. This Internet site is suited for wireless terminals with limited capabilities, like small screens and low bandwidth. The service was launched in December 1999, but has not had the growth of use as expected. During September 2000 only 2627 users connected to the service (Trafikanten 2000). Like the WWW service this is what I in chapter 4 categorized as a micro or mini application offered to individuals. It is a result of a product development where the users were not clearly identified before the product release. Even though the WAP service is claimed to be almost a direct translation of the WWW service there are a few differences. In contrast to the WWW service where you can fill in all the details in one page and then make the search, you can only fill in one piece of information at each page in the WAP service.



Figure 6.5: An illustration of the WAP service offered by Trafikanten.

The WAP service is like the call center service also offered via phones, even though they need to be WAP enabled. But this is a permanent service, where the information lasts after you "hang up", in contrast to the transient service mentioned above. The information is stored in your phone until you delete it manually. The difference between a transient and a permanent service is so essential that I believe it influences the

way people use the services.

### **6.1.2 My cooperation with Trafikanten**

My connection with Trafikanten is twofold. First, I got in contact with them because of their early release of a WAP service. I thought it would be interesting to study how this service was developed and used, and to see what role it played among the other services they provide. Establishing a contact with Trafikanten provided me with the possibility to see how a service for wireless terminals was working in real life. The information I have gained about Trafikanten is mainly gathered through interviews with a few of the employees. But I have also gained knowledge by talking to people who use their services and actually using the services myself. The questions and results of a preliminary survey of the Internet service offered by Trafikanten can be found in appendix A.

Secondly, I cooperated with a group of students who worked on a project where they studied Trafikanten's WAP service. They did most of their work without much contact with Trafikanten, but the group and I once visited them and had a conversation where the group presented their results so far in the project. The final result of their project can be found in the report by Solheim, Nordlund, Kristensen, Vågsnes and Smevold (2000). Their work consisted of evaluating the WAP service, looking for what prevailing criteria of success could be found for the service and developing a prototype based on their own suggestions of improvements. They also accomplished user surveys to get second opinions about both the original service and the prototype service. The prototype is described in more detail below.

### **6.1.3 A WAP service prototype**

After analyzing the results of the user survey the IN-DIW student group (IN-DIW 2000) did of Trafikanten's WAP service (see appendix C), they decided to develop a WAP prototype where efficiency and ease of use were the main goals. The user survey showed that a problem with the original WAP service was that it took a long time to search for travel routes. The main reason for this was that the users had to type in most of the information manually. With a numerical keyboard with just a few buttons it is quite obvious that typing is time demanding. The survey also indicated that the use of words was a source of confusion.

To make the WAP service a better one, the IN-DIW student group suggests a solution based on personification of the service. This means a service one can log into with a password and have access to personal



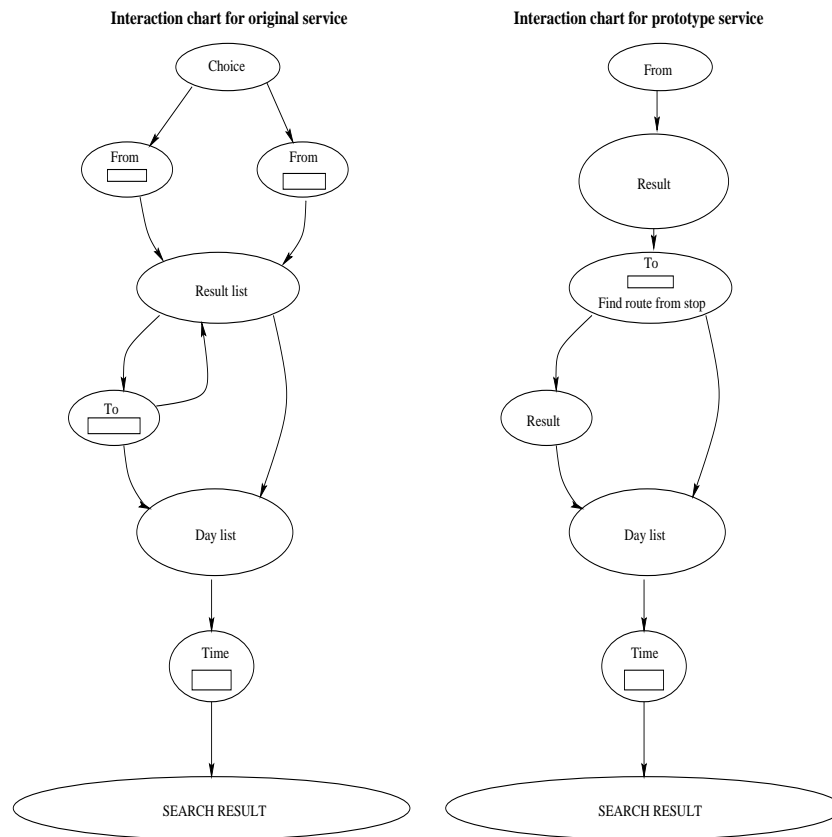


Figure 6.6: To the left is the interaction chart for the original WAP service and to the right is the interaction chart for the prototype service.

adjustments. The prototype is an attempt to make a service with fewer steps of interaction and to eliminate, or at least reduce, the possibilities for making incorrect choices. These improvements should not be at the expense of the functionality in the original service. Figure 6.6 shows the two interaction charts<sup>1</sup> for the original WAP service and the prototype. These charts are worked out by the IN-DIW student group after investigating both the original service and the prototype. As we can see there are less steps to go through in the prototype and the group has managed to eliminate the first confusing choice the users have to make in the original service. The user survey in appendix C shows that the respondents actually used up to ten minutes on a search because of problems with the first choice in the service. Whatever choice you make in the first page of the original service, the next page is where the user enters what stop he wants to leave from. In the prototype the user types in where

<sup>1</sup>The charts are translated from Norwegian.

he wants to leave from on the first page. This way the prototype has a lower number of interaction steps than the original service.

A personification of the service is also a way to lower the steps of interaction. If you take the time to adjust the service for your own needs, for example by making the service remember stops or couple of stops you access often, you will save the number of interaction steps you need to go through.

The prototype also consists of a web interface which can be used to personify the WAP service as mentioned above. This web interface is a seamless integration with the WAP service. You can log into the web site, identifying yourself with for example your mobile phone number and a password, and make adjustments suited your use of the WAP service. After making such adjustments you can access them by logging into the WAP service. The advantage with a seamless integration like this is that you do not have to use the WAP interface to make adjustments, but use the more convenient interface you have on a computer. A more thorough description of the prototype can be found in Solheim et al. (2000).

## **6.2 Ementor ASA**

My second case was accomplished at a consultancy firm called Ementor ASA. I worked there for nine weeks during the summer of 2000 and I had an interview with one of their developers. Ementor ASA is Merkantildata's business unit for e-business consulting.

During the period I worked at Ementor I learned a lot about developing services for wireless terminals. I have tried to take advantage of this new knowledge when writing about mobile services in this thesis. The project I attended was supposed to result in an intranet on WAP for the employees. It should among other things have been possible to read mail, search for phone numbers and read news about Ementor on WAP enabled devices. We did not finish the project during my work period, but I know that they continued the work after I left.

### **6.2.1 Interview with a developer**

I did an interview with one of Ementor's developers, who I will call the respondent in the following. He has a cand.scient. degree from the University of Oslo and has gained experience in developing both traditional systems, WWW services and also WAP services during his two years period of engagement at Ementor. He started working for Ementor when he finished his cand.scient. degree, but has also been engaged as a

developer for Foto.no for four years. When he was a student he was web master for the IRIS conference (IRIS 1997).

The main purpose of the interview was to gather information about developing different types of systems from someone who had experience in such development. Among other systems the respondent had developed a traditional solution for Bama that helps providers of grocery to plan the flow of grocery, and a system to be used at a hospital. His experience with WWW or Internet development was mainly from his work for Foto.no, which is a web site for people interested in photography. He has also developed several intranet solutions during his period at Ementor. When it comes to developing mobile solutions the respondent had done some work in developing a WAP service for Foto.no. This was almost an transition of the WWW service. This service is also offered to PDA users through a service called AvantGo (2001). In addition, he has been in Singapore, where he developed a WAP system for distributors of news papers.

I asked the respondent what he thought was the main differences in developing traditional services, Internet services and mobile services. What he felt was the main difference between developing intranet solutions and traditional solutions was the interface. Most other aspects were the same. But when it came to Internet development he felt he had succeeded with the method he uses when developing the Foto.no site. This is a user oriented method based on the dialogue a developer can have with the users in a web interface. Through discussion groups he get wishes and answers on questions from users, and he can promote suggestions that he would like a response on. Based on the information he gets he develops prototypes, which are tested in real use. The prototypes are changed and improved based on the users' reactions. When developing mobile services, or WAP services which the respondent had experience with, one has to take into consideration the limitations of the WAP device. Especially WAP phones have small screens and limited possibilities of navigation. WAP services are not as visible as WWW services, there are fewer users and it lacks the channel for response. People are not interested in giving response when they have to make many button clicks just to write one small word.

So far the user plays a different role when developing mobile services than developing traditional services. The users of mobile services have not reached a critical mass yet and are therefore not as included in the process as they are in traditional development. When the users reach the critical mass, it will be more interesting to develop mobile services and the users will also play a more central part.

Even though the respondent thinks the technology of today is very excit-

ing, he do not think it will revolutionize the development of mobile services over the night. New technology needs to mature before it becomes usable and successful. If we take a look at the WWW sites from 1994-1995 they are not very good, but many of today's sites are extremely good. This is because the technology has had the time to mature.

### 6.2.2 My work at Ementor

During the summer of 2000 I spent nine weeks working for Ementor. The work consisted of developing parts of an intranet system on WAP for the employees at Ementor. I was supposed to develop the functionality for reading e-mail, reading news about Ementor and searching for employees' phone numbers. This was very interesting and challenging since it was so closely related to my cand.scient. thesis.

I will not go into detail in exactly what I did during these nine weeks. The essence of it is that I gained knowledge in developing mobile services, both in the planning phase and in the actual development process. I think the main experience I gained was that the field I was working in is very immature. The technology is new and people know little about it. And since I had little experience in the field myself, I had to read a lot and "try and fail" to learn the basics of mobile development.

Both what I experienced myself when working at Ementor and the interview with one of their developers indicate that one have to think different when developing mobile services. This is partly because of the conditions of wireless terminals, like small screens, low bandwidth and small keyboards, but also because there is a claim for other services when you are on the move than when you are not.

## 6.3 A discussion of the cases

The purpose of doing investigations at Trafikanten was to consider the services' central and peripheral properties and to see if Nielsen's (1993) heuristics could be recognized in the services. In chapter 2 I argued for why I have focused on the central and peripheral properties and not the border properties. I have chosen to concentrate on four of the services Trafikanten offers. These are the paper based timetables, the call center service, the WWW service and the WAP service.

### 6.3.1 Central and peripheral properties

In figure 6.7 I have tried to illustrate the fact that different services can have mutual properties. In the case of Trafikanten the WAP service is supposed to provide much of the same functionality as the WWW service does. It is therefore interesting to see if some of the properties for the WWW service also exist for the WAP service.

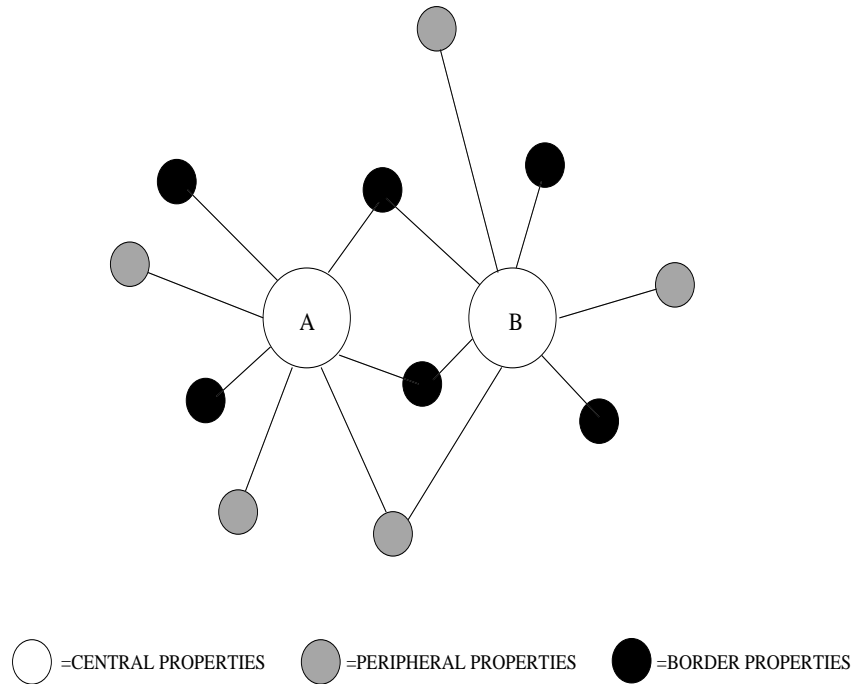


Figure 6.7: Different services, A and B, can have mutual properties.

The four services I have chosen to concentrate on all provide much of the same information. At least they all give information about arrival and departure times for different public transport in the area of Oslo. The paper based timetables is the only static service and can therefore be regarded as the least flexible one. But it has properties the others miss and is in fact quite mobile, in that you can bring it with you or move it from one place to another. In addition to the call center service, the paper based timetables are one of the first services Trafikanten provided. But lately the trend has been an evolution towards more electronic services, like the WWW service and the WAP service. Trafikanten is not alone when it comes to transition from paper based systems to digital systems. This is an area which has gained enormous interest the last years (for example, see Sandahl (1999)). The most central property with the timetables, in addition to the fact that they hold information,

is that they are made of paper. In consequence, you can write on them, turn their leafs over and make dog-ears. Having this in mind there are numerous peripheral properties to identify. The fact that it is permanent artifacts we are talking about, makes it hard to update them unless you write something on them yourself. The timetable booklet is durable for just a certain period. Just like milk, it has a date of expiry showing when the timetables are not valid anymore. The way many of the timetables are used, make them physically worn because they are made of paper. You take them in and out of pockets, bags and drawers, and turn over the leafs, which at a point makes them worn out.

The call center service is characterized by the fact that information is given to you by voice during a phone call. This central property makes the service a transient one, which I will consider as a peripheral property. Once the caller finish the phone call the information can only be found in the callers mind, on the note he might have written or by making the phone call once more.

What can be considered to be the central properties of the WWW service are that you can find the fastest route by public transport from one stop to another by typing in some parameters. What is interesting about the WWW service is that the number of users has been increasing at an enormous rate since the service was launched. By the summer of 2000 the number of users passed the number of visitors at the service center (Trafikanten 2000). This could imply that the service has the properties needed to make people use the service.

Even though the WAP service has not been used as much as expected, it has a few very interesting properties. The central ones are that you can search for information when you are on the move and that the search result is saved in your mobile phone until you erase it. The main peripheral property must then be that you can go back and check the result at a later time, you do not have to remember the search result. When comparing this service with the other services mentioned above, we actually see that it holds a combination of some of their properties. It is mobile like a paper based timetable, but not static. You can make a search based on a few parameters like the WWW service, but you are not bound to the computer. You can access the service through a phone, like the call center service, but the information is not transient.

### 6.3.2 Design heuristics

In chapter 2 I presented ten design heuristics put forward by Nielsen (1993) and I also tried to see them in light of mobile informatics. Here I have chosen three of the ten heuristics and discuss them on the back-

ground of the Trafikanten case. These three are *minimize user memory load*, *consistency* and *feedback*. The reason for why I have chosen to concentrate on these three is that I believe they play a central role in designing services for wireless terminals. The others are also important, but more obvious principles.

When it comes to WAP services used on mobile phones in particular, you need to press the phone's buttons many times to use them and they also cost money. This makes it important to optimize for performance for these services.

### **Minimize user memory load**

To minimize user memory load is a crucial aspect for designing wireless services. In a situation where the user is on the move he can not always pay full attention to the wireless terminal and should therefore not have to remember codes, numbers or other information from one part of an application to another. One way of minimizing user memory load is to make sure the service has as few interaction steps as possible. This is what the IN-DIW group aimed at when developing their prototype. Their solution required less interaction steps than the original service and for that reason the users do not have to remember as much as in the original service, where the number of steps were higher.

### **Consistency**

Consistency is the second heuristic I will discuss. As we saw in the presentation of the theory there are arguments for and against consistency. Here I will discuss it in the light of the Trafikanten case, where one service is offered in several different media. For that reason I believe it is important to provide consistency across these media. This is what Grudin (1989) calls external consistency. If we consider the four services I have looked at there is an obvious consistency between the WAP service and the WWW service. Since the users of the WAP service probably are much the same as the users of the WWW service, the consistency is of great account. This way the users can recognize the features of one service when using the other. They do not have to learn all the aspects of a service from the ground when they are familiar with the other service. For the WAP and the WWW service it is typically the way parameters should be given that is consistent.

## Feedback

The feedback heuristic plays a special role in designing wireless communication services. This is for the same reason as for the first heuristic I discussed, namely that users on the move not always have their attention directed at the terminal. The users need to know that the service is responding to their actions, and in many situations the best feedback is sound or light signals. For the wireless WAP service provided by Trafikanten one can assume that the user can direct the attention to the WAP enabled device, since he or she is performing a deliberate search that results in a written response which requires visual attention. In this case it is the quality of the written feedback that is interesting and it seems that it is acceptable.

### 6.3.3 Bringing it together

So far I have discussed the theories separately based on the results of the case. This section discusses the case on the background of a combination of the theories. One way to combine the theories is to see if any of the design heuristics can be recognized as a result in an artifact's properties. This can be better explained by an example. Let us imagine we are looking at the design of a web site. We can see that it gives us feedback in form of a sound signal when we click on a button in the interface. The designers have followed the design heuristic about providing feedback to user action. If we try to observe the web site's central and peripheral properties we might see that one of its peripheral properties is that the user knows when he has performed a click in the interface. It is reasonable to assume that this property is a result of the designer's awareness of providing feedback.

When we look at the prototype developed in the Trafikanten case we can do a similar observation. One of the goals of the designers of this prototype was to minimize the users' memory load, by lowering the number of interaction steps in proportions to the original service. If we consider the fact that the user needs to press fewer buttons than in the original service to perform a search as a peripheral property, there is an obvious link between the designers' intentions and the service's peripheral property.

As mentioned earlier in the discussion of the consistency heuristic, there was an obvious consistency between the WAP and the WWW service offered by Trafikanten. I believe we can assume that the designers of the WAP service, which was developed after the WWW service, deliberately designed for consistency between the services. The prototype is also consistent with the WWW service. A result of this design can be



seen in the peripheral property of the WAP service which states that the users recognize the WWW service when using the WAP service, and it is consequently easier to use the service when you know how to use the WWW service.

It is not only the peripheral properties that are a result of following certain design principles. The feedback mechanism in Trafikanten's WAP service is one of its central properties and a result of the design of the service where written feedback was one of the features required in the service.

## Chapter 7

# Conclusion and further work

### 7.1 Summary and conclusion

During the last one and a half year I have done research in the area of mobile informatics. My starting point was the connection with Trafikanten and my interest for their services, especially the wireless one. Knowing little about mobile informatics I had to study a lot of articles and books about the subject to get a foundation of knowledge to work upon. This foundation, together with my case studies, has resulted in this thesis, where I have discussed the following problem statement:

*How does traditional system development differ from developing services for wireless terminals?*

In order to discuss and answer this statement I chose to use a set of methods and theories. The prominent methods include literature studies and interviews, but other methods have also been used, as described in chapter 3. Concerning the theories, I have used the theory of borderline issues (Brown and Duguid 1994) as a tool to get aware of artifacts' central and peripheral properties. In this case the artifacts were services provided by Trafikanten. The theory is a general one, but I have applied it to wireless communication services and found that it is a helpful tool to recognize the context or the situation a service will be used in.

The design heuristics (Nielsen 1993), which is the second theory I made use of, applies generally to computer systems, but was presented before the interest for mobile informatics grew to what it is today. I chose to discuss three of these heuristics, which I consider especially important for designing wireless services. I applied the principles of minimizing user memory load, consistency and feedback to the wireless communication service described in the Trafikanten case.

There is not a "one sentence" answer to the problem statement expressed above, but I hope the discussions throughout this thesis help contribute to an understanding of the problem and the answer to it. Based on what I have done and seen during my research, I believe one should emphasize the importance of an artifact's context and how it will be used in certain situations. In my case I have looked at both the context of wireless services and, through my discussion of traditional system development, at the context of traditional, fixed plug systems. These can differ in a large extent, something which should be taken into consideration when designing such systems. One way to do that is to look at the systems' properties and try to attain desired properties by following certain design principles. As we saw in chapter 4, the wireless services could be placed among the micro and mini applications in the software universe. This was based on the fact that wireless services are of a personal character. But even though there is a similarity between these and traditional micro and mini applications, the way they are used vary, because they are used in different situations. When we ignore the technical differences of traditional and wireless systems, I believe the main factor that distinguishes them from each other is the context or situation they will be used in.

What can be said generally about developing services for wireless terminals is that there seem to be no established methods for how to develop them. The "try-and-fail" method and simple translation of existing systems for fixed plug terminals are frequently used methods for mobile development. When trying to establish methods, I believe it is important to be aware of what I emphasized above, the importance of an artifact's context and the situation in which it will be used. This is what Brown and Duguid (1994) encourages us to do in their theory. If one also take into consideration especially the three design heuristics I discussed earlier, there should be a good start for how to develop wireless communication services.

## 7.2 Further work

I close this thesis with a few words about what further work or research can be done in the area I have written about.

Since my thesis is mostly based on theoretical work I believe one can achieve many results by trying it out in practice. By this I mean to test Nielsen's (1993) heuristics on services on terminals with and without a fixed plug, use the properties of a terminal or service of some kind as a basis for design, and actually see whether the same principles apply for both stationary and mobile development. One way to do this is to

have two groups working on the same project, but solving the problem in different ways. One group can make use of the artifact's properties and design heuristics and the other can do it in another way, to see if there are any differences in the results.

More concrete work can be done for the services provided by Trafikanten. The prototype developed by the IN-DIW student group (Solheim et al. 2000) is one such example. Other areas are:

- One could extend the WAP service with map functionality. Once you have a search result you also get an opportunity to see the resulting route or the stops you are leaving from and to on a digitalized map.
- A service I believe would be useful, is one adjusted for PDAs. This type of service could be inspired by the AvantGo (2001) service, where you connect a PDA to the Internet and synchronize it with predefined services. The idea is to synchronize with the Trafikanten service and get updated information about public transport right into your PDA. This service would differ from the WAP service, by the fact that you could download predefined routes and you would not have to be online to look up a route. The only time you would need to be online is while synchronizing the PDA.
- Location based services are another interesting area. By integrating GPS<sup>1</sup> with a mobile phone one can make use of the information about where a mobile phone is located and for example find the fastest route to a stop given by the user. This way the user do not have to type in where he wants to leave from. It is assumed that he would like to leave from the stop located closest to him and his phone.

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<sup>1</sup>GPS is an abbreviation for Global Positioning System

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## **Appendix A**

# **Preliminary user survey (in Norwegian)**

En innledende brukerundersøkelse av internett-tjenesten til Trafikanten.

### **Deltagere**

- Ni personer, hvorav syv med utdanning innen IT.

### **Hvor ofte bruker du Trafikantens tilbud på internett?**

- 0-2 ganger i uken. Bruken er ikke spesielt jevnt fordelt over uken.
- 1-3 ganger i uken.
- Ca. 1 gang per uke.
- Av og til. (1-2 ganger i måneden).
- Av og til. Dersom jeg skal et sted jeg ikke pleier å dra til.
- 4 ganger det siste året.
- Ca. 5 ganger i uka, mer når jeg ikke studerer (jobber i Asker).
- Har brukt den en gang hittil, men ser ikke bort fra at jeg vil bruke den igjen innen kort tid.
- Sjelden. Max en gang pr. måned.

**Hvilke forventninger har du til tjenesten og blir de oppfylt?**

- Har egentlig ikke hatt noen forventninger til tjenesten på forhånd, i og med at jeg ikke visste om den før jeg prøvde den. Forventningene har da bygget seg opp på det jeg har opplevd der.
- At siden er blå hver gang jeg logger inn (oppfylt):  
At siden aldri er nede (oppfylt).  
At siden finner beste alternativ.
- Forventer å finne de opplysninger jeg er ute etter :) Jeg har alltid funnet det jeg har lett etter.
- Etter å ha brukt tjenesten noen ganger, forventet jeg meg at den skulle være oppe, og gi meg korrekte rutetider. Det har den alltid gjort (når jeg har brukt den ihvertfall).
- Forventningene er å finne svar på når og hvordan, og det har stort sett gått bra.
- At jeg skal kunne skrive hvor jeg skal, klokkeslett, hvor jeg vil dra fra. Det er akkurat det jeg får.
- Ja, informasjonen er riktig, men Sporveien er ofte forsinket så det er ikke alltid rutene lar seg gjennomføre (spesielt viktig ved overgang fra NSB til Sporveien eller omvendt)
- Jeg trodde man fikk opp alternativer til hvordan man kunne komme til og fra forskjellige steder, noe jeg ikke fikk. Jeg fikk også angitt tid som ikke passet til min angivelse.
- Jeg forventer at de skal gi meg svar på buss-, t-bane- og togtider for Oslos lokaltrafikk. Ja, de blir oppfylt.

**Hvordan synes du responstiden er?**

- Responstiden er meget bra.
- Helt grei.
- Bra. Man trenger ikke vente på svar.
- Helt grei. Ikke spesielt rask, men såpass at jeg velger den framfor å bla i rutetabellen.
- Helt greit.
- Grei.

- Stort sett grei, men dårlig båndbredde på ettermiddagen gjør at jeg ofte sjekker opp aktuelle rutetider på forhånd.
- Den var kjapp, måtte ikke vente lenge for å få opp alternativet.
- Bra.

### Har du noen ønsker om forbedringer? I tilfelle hvilke?

- Ingen jeg kommer på umiddelbart hvertfall... det eneste måtte vært utbedret oversikt, mao, flere ruter, ikke bare i Oslo.
- Kart!!!  
Liste over flere reisealternativer på samme side.  
Flere variabler, f.eks. min. overganger, min. venting.
- Bedre muligheter for søking etter stasjoner (uppercase - lowercase bokstaver også).
- Det hadde selvfølgelig vært fint om man kunne søke på enda flere ruter (flere tog og bussruter).  
Bedre responstid ønsker man jo alltid.  
Kanskje "name completer" på stoppestedsnavn.
- Litt bedre muligheter til å finne navn på stoppesteder. Så vidt jeg har forstått, bør man nå vite navnet på holdeplassen man skal til/fra.  
Det var lagt ut noen kart, men de var for små til å kunne se på skjerm (det er litt upraktisk å måtte printe ut).  
Det hadde også vært fint om man fikk forslag til alternative stoppesteder (liknende ord) dersom man f. eks skrev en liten feil i navnet.
- Nei.
- JavaScript implementasjonen kunne vært gjort mer effektiv, den bruker ofte lang tid ved høy load, man kunne feks. gjort mer bruk av cookies slik at dersom man ofte lurte på en strekning så slipper man å klikke seg gjennom mange valg som man gjør hver gang.
- Kanskje flere alternativer hvor buss, trikk og bane koresponderer. Samt at når jeg taster 11.30, så skal det ikke komme opp en buss som går 13.10. Bør kunne fungere mer spesifikt.
- Bruker det så sjelden, at de tjenestene som er der idag fyller mine behov. Har ingen behov for endringer.

**Hva synes du om brukergrensesnittet?**

- Brukergrensesnittet er sånn passe. Hverken veldig spesielt, men heller ikke dårlig.
- Bra. Enkelt å forstå, ryddig, oversiktlig.
- Ok. Kunne vært litt større felt.
- Ganske bra. Fint at man treffer søkesiden direkte, og at den er enkel, grei og selvforklarende.
- Det hadde vært fint med litt større skrift på start siden. (Det hadde også vært greit å bruke mellomrom mellom ord).
- Lettforståelig.
- Greit nok. Ser frem til en WAP implementasjon ;)
- Oppdaget ikke det. (Respondenten visste ikke hva brukergrensesnitt var.)
- Bra.

**Hva er ditt helhetsinntrykk av tjenesten?**

- Jeg liker tjenesten veldig bra. Det er mye enklere å slå opp der enn å måtte lete i ruteboken.
- Tjenesten fungerer bra nok for meg, helt ok tjeneste.
- Bra.
- Jeg synes tjenesten er bra.
- Praktisk tilbud dersom man klarer å finne et holdeplassnavn på der man skal/kommer fra.
- Kjekk å ha når du ikke har rutetabeller, digg at den sier ta buss til dit, trikk fra dit til dit og så t-bane, deretter trikk.
- De hadde problemer med JavaScript tidligere, sist jeg sjekket ser det ut til at de fleste av disse problemene er fikset. Problemene var mest synlige dersom man brukte en browser som fulgte HTML og JavaScript standardene, men som ikke var Explorer eller Netscape.
- Sikkert ok, når man har brukt den noen ganger. Da jeg ikke har gjort det, er den kanskje ikke helt brukervennlig for ny begynnere.
- Bra.

## **Appendix B**

### **Scenarios**

This appendix presents a few scenarios used to identify the central and peripheral properties in the services offered by Trafikanten.

#### **Scenario 1**

John suddenly woke up and looked around with a confused mind. It was Monday morning, he thought, but it was already passed noon. He had not heard the alarm clock and had overslept. He was going to miss the bus for the airport. It left ten minutes ago. "What do I do now?", he thought as he threw on some clothes. He rummaged the drawer, but could not find the public transport timetable. "I have to catch that plane!". He gave up searching for the timetable. The dog must have eaten it a long time ago. Then he remembered the call center service offered by Trafikanten. But what was the phone number? "Why did the car have to break down yesterday?" 177! That is the number. While brushing his teeth he dialed 177 and was informed that a bus was leaving in five minutes. If he took that bus he could just catch the train to the airport. He looked at his watch, which now was twelve thirty. The plane left in just over an hour. There was no time to loose.

#### **Scenario 2**

Sam and Jane run as fast as they can to catch the bus. They are late as usual and miss the bus. Fortunately Sam has a pocket sized timetable in his bag and takes it up to check when the next bus is leaving. He also checks for alternative buses and finds out that they can take another bus leaving from a stop hundred meters from where they are. The bus leaves

in five minutes, so they have time to walk to that stop.

### **Scenario 3**

It is the night before an important soccer game and Tom needs to know how to get to the stadium. He turns on his computer, connects to the Internet and opens Trafikanten's web service on [www.trafikanten.no](http://www.trafikanten.no). He has used the service several times before and thinks it is a good service. He types in the different parameters, like from where he is leaving, to where he is going and at what time. The result based on these parameters is the fastest travel route to where he is going.

### **Scenario 4**

Tina is expecting guests when she comes home from work. They are planning to take the subway, because both Tina and the guests have a subway stop right outside their door. Tina has been told that they are going to take the subway leaving at five o'clock. "When do I have to be home?", Tina wonders. She checks the Internet service provided by Trafikanten and finds out that the subway the guests are riding will arrive at five past half six. "Ok, I need to be home at half six then." But to be home at half six, Tina needs to check how to get home at that time and uses the Trafikanten service once again.

### **Scenario 5**

Thomas was waiting for the bus, but it seemed to be late. He went to check the timetable, but it was destroyed by some kids. Instead he picked up his WAP enabled mobile phone and connected to the Trafikanten WAP service. With a few "clicks" he found out that the next bus was leaving in just a few minutes, so he decided to wait for that.

### **Scenario 6**

He usually drove the car to and from work, but today the car was at the workshop and he had to take the bus. He had a timetable booklet in the drawer in his office and took it out to see when the bus was leaving for home. The timetable he needed to look at had a dog-ear from the last

time he had to take the bus home, so it was easy to find it. He had also marked the stop to leave from to quickly find it when he looked at the timetable.

## **Scenario 7**

Mary just missed the train for the airport and needed to know when the airport bus was leaving. She took out her ordinary mobile phone from her purse and called Trafikanten's call center to get the information. At the same time she raced through all the people at the railway station heading for the bus stop. After a few seconds she had contact with one of the call center's operators who asked her what information she wanted. "When is the first bus leaving for the airport? I am at the railway station now." Mary said. The operator responded quickly and said "You can take a bus from bus stop A which leaves 14.55 or you can take the bus leaving from bus stop B at 14.58." "Okay, thank you", Mary said and ran all she could towards the stops. When she was approaching stop B she suddenly stopped and wondered what the operator had told her. "Was the bus leaving at 14.55 or 14.58 from stop B?" She had to call one more time to find out.

## **Scenario 8**

Tony just missed the train for the airport and needed to know when the airport bus was leaving. He took out his WAP enabled mobile phone from his pocket and connected to Trafikanten's WAP service. At the same time he tried to get through the crowd of people at the railway station heading for the bus stop. After a few seconds he had contact with the service and made a search for the route he wanted. "When is the first bus leaving for the airport from bus stop A?" The service came up with a search result telling him that a bus was leaving at 14.55 from bus stop A. It also informed him that another bus was leaving from bus stop B at 14.58. When he was approaching stop B Tony suddenly stopped and wondered if the bus leaving from stop B left 14.55 or 14.58?" He took out his mobile phone again and checked the search result, which he fortunately had not deleted.

## **Appendix C**

# **IN-DIW user surveys (in Norwegian)**

### **C.1 Brukertest av Trafikantens WAP-tjeneste**

#### **Test oppgaver**

Vi ga brukerne følgende oppgaver:

1. Finn en rute hjemmefra til jobb på en vanlig arbeidsdag.
2. Finn en rute fra Blindern til Bogerud på det nåværende tidspunkt.
3. Finn en reiserute fra Karl Johan og hjem. Nåværende tidspunkt.

#### **Kvalitative spørsmål**

Til slutt fikk kandidatene svare på følgende spørsmål:

1. Hva synes du om Trafikanten på WAP?
2. Følte du det var greit å finne hjelp dersom du trengte det?
3. Hva synes du om Trafikantens WAP-tjeneste i forhold til Trafikantens andre tilbud? Hva ville du ha valgt? I hvilke situasjoner kunne du ha tenkt deg å bruke WAP-tjenesten?

#### **Formål**

Utgangspunktet for å utføre en brukertest av Trafikantens WAP-tjeneste var et ønske om å få evaluert tjenesten av utenforstående som ikke så



på tjenesten på samme måte som vi i gruppen gjorde. Vi hadde også endel tanker om hva som var såkalt bra og mindre bra ved tjenesten [2]. Samtidig med at vi ønsket å bekrefte eller avkrefte våre antagelser ønsket vi også å få en pekepinn på det tidsforbruket som preger bruken av tjenesten. Dette vil vi gjøre for å kunne veie nytten av en slik tjeneste opp mot bruken av for eksempel Trafikanten sin opplysningstjeneste på telefonnummer 177. Vi anser at WAP-tjenesten ikke bør overstige opplysning via 177 i tidsforbruk for at WAP-løsningen skal være et reelt alternativ til ruteopplysning. Dette fordi begge tjenestene for øyeblikket koster penger ved at brukeren blir belastet med tellerskritt. Videre ønsket vi gjennom testing å se i hvilke situasjoner interaksjonen i tjenesten hadde svakheter samt om det var mulig for brukere å “rote” seg bort i tjenesten.

### Utførelse

For å teste tjenesten valgte vi 4 testpersoner som ikke tidligere hadde brukt Trafikantens WAP-tjeneste. [3] og [1] viser til studier innen henholdsvis brukervennlighet og grensesnitt-forståelse og konkluderer med at 4-5 testpersoner dekker mellom 75 og 80 % av alle feil. Det viste seg også senere at brukerne aldri hadde brukt WAP overhodet, dermed kan vi si at alle testerne hadde likt utgangspunkt med tanke på WAP-erfaring. For å gjøre testingen så realistisk som mulig benyttet vi en Nokia 7110 mobiltelefon med WAP-browser.

Hver av de 4 testkandidatene fikk sitte i fred og ro uten noen av de andre kandidatene tilstede. Det var allikevel mulig for kandidatene å stille spørsmål til oss dersom de stod fast [2]. Først gav vi kandidaten en og en praktisk oppgave og så fikk de til slutt besvare 3 enkle spørsmål om hvordan de oppfattet tjenesten. Årsaken til at vi valgte denne metoden lå i at vi ønsket at brukerne skulle få prøve de forskjellige interaksjonsmulighetene som ligger i tjenesten. Samtidig som vi ønsket variasjon, så ønsket vi også repetisjon i oppgavene slik at vi kunne få et hint om hvor stor del av eventuelle hindringer som oppstod på grunn av bruk av et uvant medium og hvor stor del tjenesten selv skapte. Over kan du se de tre praktiske oppgavene. Første og siste oppgave vil variere fra bruker til bruker, mens oppgave 2 vil være lik for alle brukerne. Oppgaveløsingen ble tatt opp på bånd slik at den lett kunne aksesseres og evalueres også etter den ble gjort. Vi ba intervjuobjektene snakke så mye som mulig slik at vi kunne plukke opp hvilke tanker de gjorde seg under testene. Kommentarer og vurderinger underveis ble notert av 2 av gruppe-medlemmene slik at vi kunne spørre om årsakene til interaksjonsvalg eller andre ting etter at kandidaten hadde løst oppgavene.

De 3 spørsmålene kan du også finne over. Med disse spørsmålene ønsket

vi å få testkandidatene til å tenke gjennom hva slags inntrykk de satt igjen med etter å ha benyttet tjenestene. Ved å analysere inntrykkene opp mot de erfaringer som kom frem under de praktiske testene kunne vi finne frem til aspekter ved tjenesten som kunne forbedres.

## Resultater

Brukertesten fikk frem endel aspekter ved tjenesten som vi i gruppen ikke hadde sett på som potensielle problemer. Det viste seg blant annet at alle testpersonene hadde vanskeligheter med å skille interaksjonsvalgene på første side fra hverandre. Flere av testpersonene brukte opptil 10 minutter på å produsere det resultatet de ville ha på grunn av feilvalg i begynnelsen av et søk. Det er mulig ordvalget i vår oppgaveformulering gjorde at kandidatene ble påvirket til en viss grad, men allikevel antar vi at ordvalget på linkene i større grad kan ha forvirret testpersonene.

Generelt tok oppgaveløsingen forholdsvis lang tid når en tenker på at WAP, som er designet for mobile terminaler, skal kunne brukes kjapt og effektivt. Blant alle testkandidatene så vi en kraftig reduisering i tiden de trengte på å løse en oppgave fra første oppgave til siste oppgave. Fra 8-10 minutter sank tiden som ble benyttet til 2 - 4 minutter. Det er viktig å merke seg at i de tilfellene det ble brukt lang tid så ble det meste av denne tiden brukt til å finne ønskede stoppesteder. Dermed gikk det nokså klart frem under testen at WAP (på mobiltelefon) har et helt annerledes interaksjonsmønster enn WEB. Bare det å skrive inn et stasjonsnavn er krevende. Det anses derfor som rimelig å anta at interaksjon via linkvalg samt scrolling i lister vil være å foretrekke fremfor innskriving av tekst.

Under gruppens evalueringer anså vi mangelen på en hjelpetjeneste som prekær. I tiden etter denne testen la Trafikanten til en side som det er linket til via førstesiden til tjenesten. Denne siden heter Brukertips. Under testingen derimot kom det klart frem at hjelp ikke ble benyttet overhodet. Ingen av kandidatene hverken tenkte på eller lette etter denne hjelpefunksjonen. Under gruppens evaluering av tjenesten ble det påpekt at det på enkelte sider manglet mulighet til å gå tilbake til forrige side. Det kom tydelig frem i testen at dette var et problem. Flere av testpersonene kjørte seg fast, og måtte til slutt få hjelp av en av gruppens medlemmer. Selv ved senere anledninger der den enkelte testperson kom opp i problemer, førte mangelen på en tilbake-knapp til at vedkommende måtte begynne på et nytt søk. Dermed ble tidsforbruket for den gjeldende oppgaven nær doblet. Til slutt kan det også poengteres at testen bekreftet at begrensningen på 6 mulige søkeresultater er vel snever. Alle testkandidatene kom opp i situasjoner der tidsforbruket økte grunnet denne begrensningen.

## C.2 Brukertest av in-diws prototype

### Test oppgaver

Følgende oppgaver er bestemt:

Før oppgaven starter lar vi brukerne teste den opprinnelige Trafikanten-tjenesten for å bli litt kjent med denne, deretter forteller vi at vi har laget et forslag der vi har lagt inn en profil på reisemønsteret til brukeren, og at testpersonen skal få prøve denne tjenesten. Vi gir testpersonen beskjed om at han bor på Stovner, jobber på Lambertseter og studerer på Blindern. Vi har så laget noen oppgaver brukeren skal løse der det er meningen at han skal bruke "Mine Reiseruter", men vi sier ikke klart fra at han skal gjøre det.

1. Kandidaten får i oppgave å finne en reiserute hjemmefra til jobb (dvs fra Stovner til Lambertseter). Dersom "Mine ruter" blir brukt så er det meget bra. Vi må da spørre brukeren hva han/hun tenkte da valget ble tatt. Søker brukeren på "vanlig" manuell måte spesifiserer vi ovenfor kandidaten at det også er mulig å benytte "Mine ruter". Også her er det viktig å få klarhet i bakgrunnen til valget som ble tatt.
2. Det blir gitt som oppgave å finne en rute fra skole til jobb. Bruker kandidaten "mine ruter" nå? Få klarhet i hvorfor, hvorfor ikke! Hvis "mine ruter" ikke blir brukt så forklarer vi testeren hvordan denne funksjonen kan benyttes.
3. Til slutt bes kandidaten om å finne en rute fra jobb og hjem til Stovner. Også her bør kandidaten forklare de valgene han/ hun gjør.

### Kvalitative spørsmål

For å fange opp eventuelle uklarheter, og få frem ting som ikke er blitt tenkt på vil vi stille testkandidatene kvalitative spørsmål.

Disse er som følger:

1. Var menyen på førstesiden lettfattelig og grei å forstå?
2. Hvordan opplevde du konseptet "Mine reiseruter"?
3. Ville du benyttet "Mine reiseruter"?
4. Ville du brukt "Mine reiseruter" hvis du måtte legge inn rutene på WEB?

5. Ville du brukt “Mine reiseruter” dersom du kunne legge til en rute etter at du har søkt den opp (som en valg mulighet på resultat-siden)?
6. Hvor mange reiseruter ville dekket mesteparten av ditt reisebehov? ....den siste uka?
7. Hvilke tilleggstenester til Trafikanten kunne du ha tenkt deg?

## Formål

Etter å ha laget en ny versjon av Trafikantens WAP-tjeneste med endring i interaksjonsgangen med hensyn på valget av *Fra holdeplass* og *Mellom holdeplasser*, og etter at vi har lagt til *Mine Reiseruter* var det behov for en ny runde med brukertesting.

Hensikten med brukertesten var å avdekke feil og mangler ved prototypen samt å finne ut om interaksjonen var intuitiv og lett å forstå. Vi ønsket også å finne ut om vårt forslag gjorde Trafikanten-tjenesten raskere på søk som blir hyppig gjentatt. Til slutt ville vi prøve å få klarhet i hvorvidt testkandidatene anser det å bruke WEB som et hjelpeverktøy til å redigere den personifiserte informasjonen på WAP som et reelt alternativ.

## Utførelse

Vi testet prototypen med 4 testkandidater. Ingen av kandidatene hadde brukt Trafikantens WAP-tjeneste, men to hadde brukt WEB-tjenesten. Vi lagde 2 forskjellige testcase der brukerne måtte bruke både *Mine reiseruter* og taste inn holdeplassnavn manuelt. I tillegg hadde vi kvalitative spørsmål for å få svar på andre aspekter rundt prototypen og dens bruk-sområder.

Under brukertesten var det på grunn av tekniske problemer ikke mulig å benytte en Nokia 7110 WAP-telefon. Dermed måtte vi bruke Nokias WAP-toolkit for Microsoft Windows-plattformen. Dette toolkitet har et identisk utseende og interaksjonsmønster som selve telefonen. Vi antar derfor at interaksjon via PC (og dette toolkitet) vil være ganske lik interaksjon med 7110 WAP-telefonen. Det kan muligens gå litt lengre tid på PC grunnet at man her kun kan benytte mus til å interagere med. Ved å måtte bruke mus så vi at enkelte av testkandidatene hadde tilbøyelighet til å forsøke å trykke direkte på linkene i displayet. Det er ikke mulig å interagere direkte via displayet på telefonen, men man må benytte den såkalte Navi-rolleren. På denne måten kan det faktum at vi måtte utføre brukertesten på en PC ha influert målingene.

## Resultater

Ved å bruke *Mine Reiseruter* fikk vi responstider ned til 12 sekunder fra oppgaven ble gitt til ruten ble presentert. Variasjoner i resultatene kan sies å komme stort sett fra varierende evne til å interagere med toolkitet.

Alle testkandidatene mente vårt forslag til interaksjonsmønster var en bra løsning. I løpet av testen hadde ingen av kandidatene problemer med å velge riktig link i forhold til den oppgaven de skulle løse. 2 av kandidatene stoppet opp og leste den nederste linken *Rutetabeller for Blindern*, men returnerte øyeblikkelig til den første linken (*Fra Blindern til ...*) og valgte denne. Da vi i etterkant spurte kandidatene hvorvidt de opplevde usikkerhet angående hvilket alternativ de skulle velge fant vi at alle mente det var intuitivt og lettfattelig med den nye interaksjonsformuleringen.

3 av testpersonene valgte *Mine Reiseruter* når de fikk i oppgave å finne en reiserute hjemmefra til jobb. Den siste testpersonen sa etterpå at han ville valgt dette alternativet, men at han ikke trodde det ville ligge noe i *Mine Reiseruter* siden det var første gang han brukte tjenesten. På spørsmål om de intuitivt skjønnte filosofien bak *Mine Reiseruter* og om de fant dette som et nyttig tjenestetilbud, var alle positive.

På spørsmål om kandidatene ville brukt *Mine Reiseruter*, svarte 3 av 4 at de ville benyttet en slik tjeneste. Den siste testpersonen sa at grunnen til at han ikke ville brukt WAP noe særlig til å slå opp rutetider, var at han stort sett husket de få rutene han benyttet. Dette viser hvor individuelt betinget et slikt tjenestetilbud kan være. Noen vil i stor grad huske de rutene de til daglig benytter og trenger dermed ikke benytte Trafikantens tjenester for ruteinformasjon. Andre vil ha behov for å slå opp de samme rutene dag etter dag. Det kan trekkes en parallell fra denne oppførselen til den en kan se i ordinært mobiltelefonbruk i dag. Mobiltelefonen fungerer, i tillegg til å være en telefon, også som telefonbok. På denne måten minsker behovet for å huske telefonnummer siden man alltid har det tilgjengelig i telefonen. På samme måte kan en tenke seg at Trafikantens tjeneste kan overta behovet for å huske rutedetaljer for kollektivtrafikk [4].

For å få en viss innsikt i mulige bruksmønstre for Trafikanten spurte vi hvor mange reiseruter som ville dekket mesteparten av testpersonenes behov for kollektivtransport. Svarene varierte fra at 2 til 10 forskjellige reiseruter ville dekket mesteparten av deres reiser.

Når det gjelder integrasjonen mot Trafikantens WEB-tjeneste så stilte de fleste seg positive til å administrere rutene via dette grensesnittet, men her var det noe delte meninger. Samtlige ville derimot tatt seg tid til å trykke en gang for å legge inn en oppsøkt rute i *Mine Reiseruter* på

WAP-telefonen dersom dette hadde vært implementert.

Til slutt spurte vi om testkandidatene hadde noen ønsker vedrørende tjenester de kunne tenke seg knyttet opp mot Trafikanten. Av de tilleggstjenester som ble nevnt noterte vi følgende:

- Varsling om forsinkelse. Mulighet for å få tilsendt en tekstmelding til mobiltelefonen dersom en rute er forsinket.
- Vise kart over reisen. Kunne vise et kart der reiseruten er avmerket.
- Koble mot gule/hvite sider. Linker fra for eksempel Gule Sider som kan gi reiserute til det gjeldende søkeresultatet.
- Lokasjonsbestemming av telefonen. Lokasjonsbestemming vil eliminere behovet for å taste inn hvor du er og dermed minker også tidsforbruket ved tjenesten.

Alle disse punktene vil på et senere tidspunkt være teknisk mulig. Dermed kan Trafikanten bli et utgangspunkt for sømløs integrering av informasjon som tradisjonelt har vært separert.

For å fange opp eventuelle ting som vi i gruppen ikke hadde tenkt på forsøkte vi å få til en uformell konversasjon rundt tjenesten og WAP i seg selv. Blant annet ble det nevnt at siden displayet på Nokia 7110 er såpass begrenset kan det, med lange stasjonsnavn, bli vanskelig å få oversikt over de forskjellige linkene på sidene. Dette kan tenkes ordnet ved at man legger en blank linje mellom hver link for å skille disse. En ulempe ved denne løsningen er at man da vil sløse bort en stor del av et allerede lite display på blanke linjer. Det vil dessuten øke behovet for scrolling.

## Referanser

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